Exploring Drawing Devices:
Translating the Patterns of the Sun for the Architecture of the Twenty First Century

by

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Submitted in partial fulfilment of the requirements
for the degree of Master of Architecture

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DALHOUSIE UNIVERSITY

SCHOOL OF ARCHITECTURE

The undersigned hereby certify that they have read and recommend to the Faculty of Graduate Studies for acceptance a thesis entitled “EXPLORING DRAWING DEVICES: TRANSLATING THE PATTERNS OF THE SUN FOR THE ARCHITECTURE OF THE TWENTY FIRST CENTURY” by Mark William Aseltine in partial fulfilment of the requirements for the degree of Master of Architecture.

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ABSTRACT

Each architectural exploration requires grounding. This body of work begins with an interest in that which made historical settlements authentic to a place. The thesis is focused first and foremost on the single most predictable, yet varying influence. The sun which acts as a clock, a calendar, and source of energy, has shaped architecture for thousands of years and should be considered with far greater attention in the future, both experientially but also thermally as source of energy.

The proposal for an artist studio located on the Northumberland Straight in Nova Scotia will require an acute relation to the light and solar energy which the sun has to offer. The studio will attempt to function as a self sufficient working space in the landscape, using the resources locally available. As sole users, each artist will shape the habitable space based on specific needs, while continually keeping in mind that which drives the form, light, heat and energy.

ACKNOWLEDGEMENTS

I would like to thank first and foremost my Parents for their never ending support. I would also like to thank Brian Lilley, Susan Molesky and Catherine Venart for giving me guidance through the duration of my thesis. Emanuel Jannash deserves thanks for his time and dedication to my field of research, and the process of making. Thanks must go out to Katherine Knight and David Craig for letting me spend time on their land over the past year. Finally I would like to thank the man behind the wall and all of my wonderful studiomates for their support and help.

INTRODUCTION

Background

This body of work reaches beyond the limits of this document and deep into the historical rituals which many cultures depended on to survive in isolated settlements with harsh climates. Architecture grew from the basic needs of survival. These needs in regions such as ours depended on heat, be it from the sun or fueling a hearth. The influence which the sun has on architectural form can be traced back thousands of years.

Building as Shelter

Historically speaking the success of architecture can be defined by it's ability to mediate between the natural climate and a more liveable and friendly interior climate. This is to say that architecture came to be the moment humans began to lose comfort in their natural surroundings. All buildings from that point on have been an enhancement of the need for shelter. Ralph L. Knowles explains the basic need for sheltering:

> We human beings, in all parts of the world and in all types of society, seek shelter--a building, a tent, or some other structure that keeps us safe and comfortable. We look for protection from the physical threats of nature and each other, a ceaseless quest that has produced an impressive array of forms...In this less tangible regard, the static concept of a shelter gives way to the dynamic concept of sheltering. (Knowles 2006, 03)

This way of thinking about architecture allows one to understand the fundamental needs required by the architect when given a task. These fundamental needs are well established traditions in every culture around the world. "Dwellings were well adapted, sited, and shaped in response to local conditions of weather and climate."(Knowles 2006, 04). This adaption to site is that which allows one to become aware of his or her sur-

"Det Glemt Huset"
(The Old House)
Gårdsvatn, Lofoten, 2010

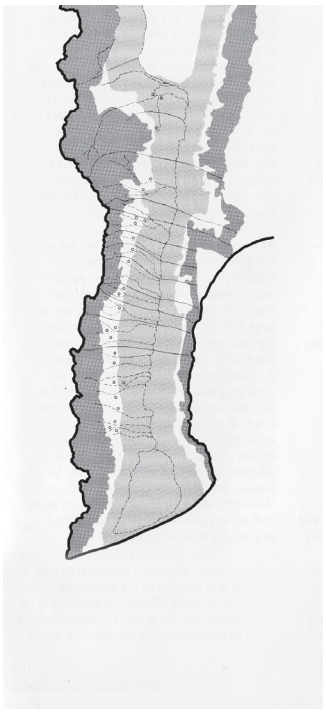
roundings, local climate, material resources, and seasonal rituals.

No matter where the settlement is located there are always dominant materials and climates worth exploring. This can be seen in the Mediterranean where stone is used to shelter from extreme heat, in Scandinavia where heavy timber and sheeps' wool can be combined to protect against the extreme cold and dark winters. These methods though different in their aesthetic all carry the same intention in their execution.

Building materials and their use are the first step towards creating the desired interior climate. They can block out wind rain, cold, and direct sun, but cannot further warm or cool a space. This act is brought on by the introduction of openings for: fire, the venturi effect, fenestration, or simply a cool body of water. These techniques are ones which develop over hundreds of years and are proven to be the most economical means of

mediating temperature in their specific region and culture. Lisa Heschong explains so very clearly the consequences architecture has, at the extreme microclimate scale of the simple placement of a square in the land;

> Buildings, even in the conventional way we now build them, can be viewed as a way to modify a landscape to create more favorable microclimates. As soon as a simple square hut is built, at least six new microclimates are created: the south side warmed by a sunny wall, the north side in shade most of the time, an east side with its morning sun and perhaps protected from the prevailing breeze, a west side warmed in the afternoon but buffeted by the wind. There is also the inside with its shelter from the rain and wind and sun, and the roof, raised above ground level, more exposed to wind and sun. A building increases the available range of thermal zones so that people can select the microclimate most suited to their thermal needs. (Heschong 1979, 08)

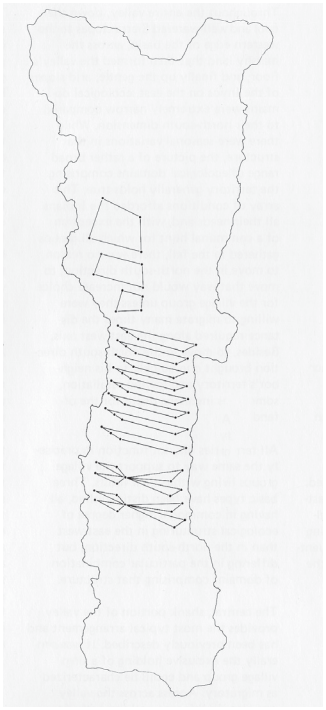


Piute Indians living in California's Owen's Valley make cyclical migration to and from the hills. Energy and Form

Seasonal Migration

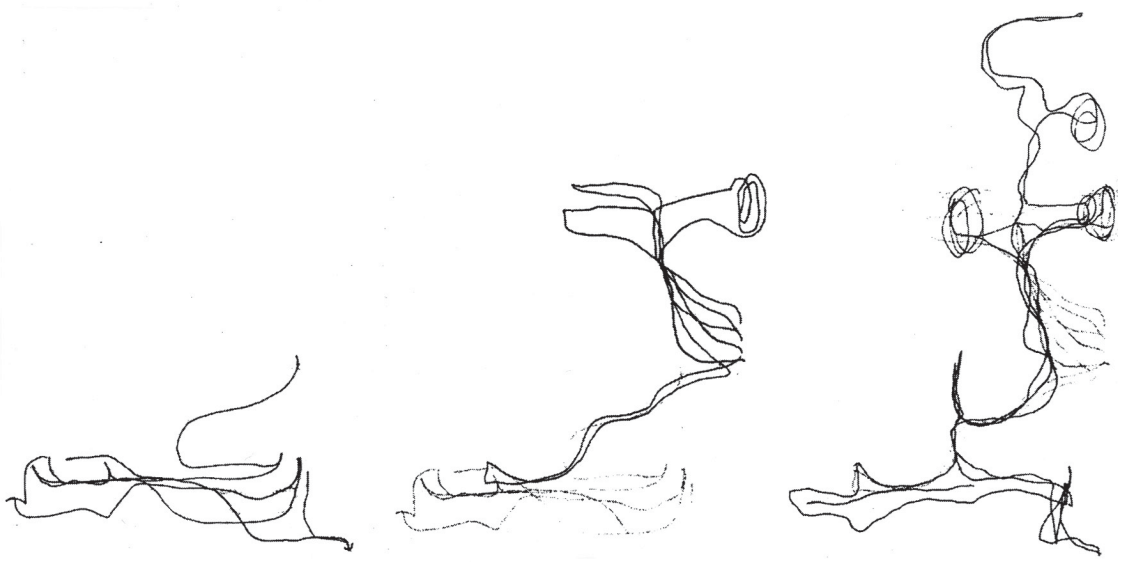
Often times, highly sophisticated shelter does not suffice in the battle for human comfort against the natural elements. This is cause for migration, a ritual which many cultures have adapted as a worthwhile change in their daily lives to achieve a more comfortable lifestyle. This change happens in many cultures at various scales.

> Each summer as the days began to lengthen and the temperature began to climb, the group moved west into the higher meadows of the Sierras. Here they enjoyed the coolness of an increased elevation. As the fall approached and passed into early winter they migrated ten to fifteen miles across the valley to the east, where they gathered pine nuts at the base of the Inyo and White Mountains. Here they were at a lower elevation and had a west and somewhat south exposure adding to their comfort as the winter days approached. The seasonal cycle was finally complete when they returned to their permanent campsite at the base of the Sierra to live out the winter in the relative comfort of primitive enclosures that could be heated in a reasonable way. (Knowles 1974, 11)



Piute Indians used an average of three sites to fulfill their cyclical needs. Energy and Form

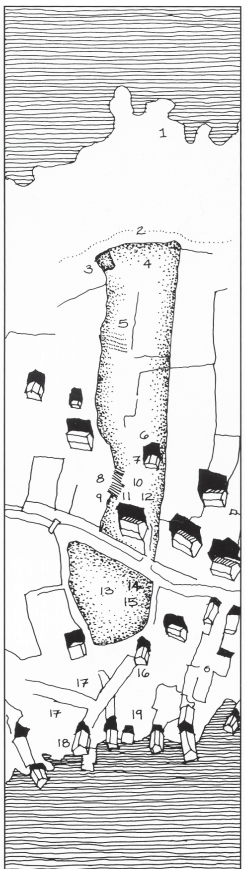
Robert Mellin describes in his book 'Tilting', the act of migration at a scale much smaller than that of the Piute in California.



"House Migrations: Winter, summer, and special holidays." Drawing by Troy Chattariyangkul. Ritual House

Taking place in a town called Tilting on Fogo island just off the northeastern coast of Newfoundland, the climate there at the best of times, barely reaches beyond the desired interior comfort level. This means there is a large need for heat. This heat requires fuel, which in their case comes in the form of wood. The process of harvesting the wood takes place every year in late summer and generally involves several of the men from the town working in groups. When the heat you use requires such a level of labour and time, you begin to understand your heated space much more intimately. You know where the heat can escape, which spaces you require to be warm, and how you might reduce the heating load while keeping your inhabitants comfortable.

Along with seasonal migration you find daily migration. This works under the same principles and needs, just at a much smaller scale and time frame. Tilting has a very clear, local example of this sort of life. The people in tilting have separate structures for every need. In a day one might migrate from house, to the cellar, to the stage. Or from the wood storage, to the stable, to the well. This becomes efficient by creating a space that is perfectly tuned for its program.



Land ownership and map of outbuildings. Tilting

Building for our Climate

Every climate and geographical location has a building culture. It is not enough to assume that two regions with similar resources will produce architecture which acts alike. The way which one will construct with wood in a cold and wet climate, will vary drastically with that in a much warmer dry region.

The most influential natural factors in a region for the development of architecture are: latitude(Sun angles), climate(temp, precipitation, etc.), vegetation(trees and food), and coastal conditions(siting, industry, etc.). Each of these elements have characters which influence the built environment.

Latitude

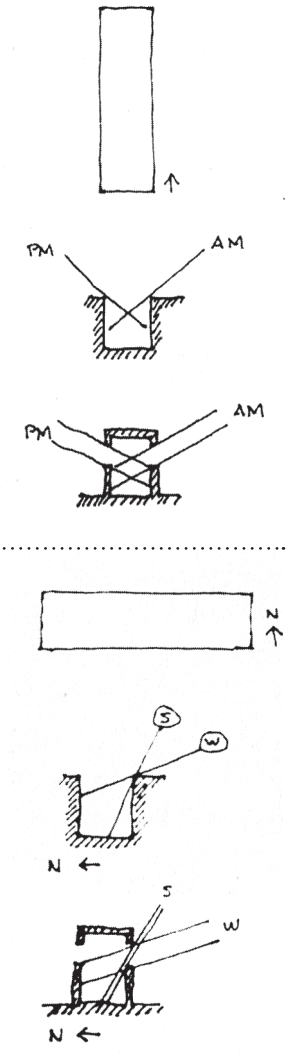
The angle of the sun and its strength has a very severe impact on how and why buildings exist. The sun determines whether a region is hot or cold and light or dark. The sun projects different angles depending on latitude and time of year. These variations are due to the fact that the earth rotates about the sun with an internal rotation angle of 23.5º. This angle causes the sun to appear in the sky at an array of altitudes throughout the year. Although varying daily, it is consistent in its actions on a solar year cycle.

Climate

The temperature, precipitation and winds are some of the most influential factors on architectural form. They shape buildings in ways all other natural forces do not. There are variations in overhangs, roof pitches, window sizes, and the placement of a building in, on or above the land.

Vegetation

Vegetation or the lack there of, determines the building construction methods for each region. Types of trees and soils are



Top: "Daily Change Accentuated in a North-South-Elongated Space. Ritual House

Bottom: "Seasonal Change Accentuated in an East-West-Elongated Space". Ritual House

critical in determining the structural qualities of the built form. Each region responds to the available resources in unique ways. The use of timber for an entire superstructure and restricting the use of stone to foundations and hearths is no aesthetic choice, but rather necessity due to their structural and combustible qualities. On the contrary, stone structures often use timber as lintels, they perform well in tension and their availability can be low, they are refrained from use.

Coastal Conditions

This region is very unique in that it has a special relationship with the sea. It has an eroding characteristic which cannot be ignored, and it brings with it a lifestyle that demands to be sited in a very unstable zone between land and sea.

These conditions are the ones which have the most influence on architecture. These subtle changes to the landscape are the ones which are critical in the experience of the place and everyday rituals that occur. These spaces require a large amount of attention in order to be successful in their intended purpose.

It is only when humans enter the architecture, that comfort can be discussed, and only when comfort is needed that building systems and interior climate become an issue. Lisa Heschong explains in her book, Thermal Delight in Architecture, that there is a need for articulation of building systems and human comfort at a scale which the user may appreciate;

> But in a typical office building, to what can we attribute the all-pervasive comfort of 70ºf, 50 per cent relative humidity? The air diffuser hidden in the hung ceiling panels? The maintenance personnel who work during off-hours? The mechanical equipment down in the basement below the parking garage? The engineer who designed the system long ago? The whole vast building itself? Most likely, we would simply take it all for granted. When thermal comfort is a constant condition, constant in both space and time, it becomes so abstract it loses its potential to focus attention. (Heschong 1979, 35)

On the contrary, those folks in Tilting who close off their second kitchen in response to climate and fueling supplies for the winter, have an extremely great understanding of the internal comfort which drives them to seasonal change.

Losing the Place

History, architectural language, and urban fabric have all been directly influenced by natural elements; Topography, proximity to materials/resources and local climate. As time passes and cultures homogenize, the need for regional architecture declines and the availability of building materials, systems and cheap fuel expand. Local patterns of architecture are slowly slipping away as a unique form of their own, and in turn they are slowly losing their authenticity and becoming lifeless. Both in urban and rural context, tendencies are shifting towards a more uniform and homogenized built environment over entire continents.

We find today there are building methods which contradict the means used in the years preceding the Industrial Age. This means there is no longer a need to look at the region for patterns about how we will settle, but rather where we can settle on the best view of that very land. The homogenized material culture allows one to build in a method which responds not at all to available resources and local conditions, but rather to the cheapest available industrially produced products from around the world, regardless of their local efficiency or application. These methods of building have great amounts of embodied energy, not only in production, transportation and waste, but also in energy usage during the life of the structure.

The shift back to a regional building type will make our future settlements far more livable and authentic to its place. It will also give them each the individuality of the process from na-

Old Farm House
Sulitjelma, Nordland,
Norway 2010

ture to structure, while expressing the knowledge of the place which has been lost in recent generations.

These early settlements had the ability to build in a way which came from the dire need for survival in a remote location with a harsh climate and minimal resources. These are the patterns we should be learning from for the future, in order to properly harvest energy forms which are continually free to use each and every day. Building in response to an increasingly unstable and placeless environment, architecture can re-invent itself while retaining an authentic building tradition.

> The more I watch our pattern language being used, the more I realize that the language does not teach people new facts about their environment. It awakens old feelings. It gives people permission to do what they have always known they wanted to do, but have shunned, in recent years, because they have been frightened and ashamed by architects who tell them that it is not "modern." People are afraid of being laughed at, for their ignorance about "art"; and

> it is this fear which makes them abandon their own stable knowledge of what is simple and right. (Alexander 1979, 544)

Tradition has lead us to an abundance of unique building types, each of which have evolved over time from an acute knowledge of the land and its natural elements. These are the real factors at play when trying to reinvent an architecture which is reflective of a local culture.

Research Question

How can the Solar Cycles of light and temperature inform a method of design, which allows the architecture to reflect the patterns of the sun?

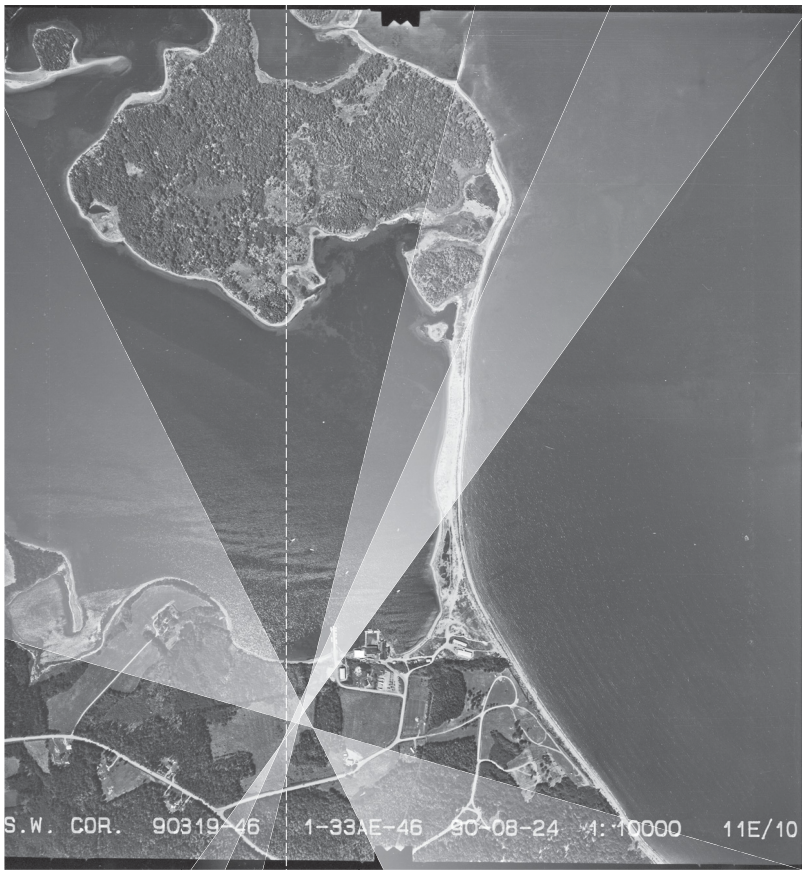
In order to design in response to a natural element, one must set a series of parameters. These parameters are key in understanding the tools which will be required for the execution of a clear design. The research conducted as background analysis along with the parameters that are set out in the following chapter, will allow me to develop a series of tools for design. These tools will become essential in this design work. Furthermore I will be able to take these tools with me to aid in future design.

DESIGN PARAMETERS

The design work in an architectural thesis is a testing ground for the research carried out over the duration of a thesis. In order to create a framework for testing the research, a site, program and client have been considered as a design context for the thesis work. This chapter outlines and sets up design parameters based on those elements.

Site

Located 5-6 km north of Pictou, Nova Scotia, the site is a 52 acre plot of land in Caribou Harbour facing Monroes Island on the Northumberland straight. It consists of only two structures, the existing residence (45 43’29” N 62 39’33” W) which was first used as a barn, then a store. Now the building has 4 bedrooms and a large kitchen and living space. The secondary structure is



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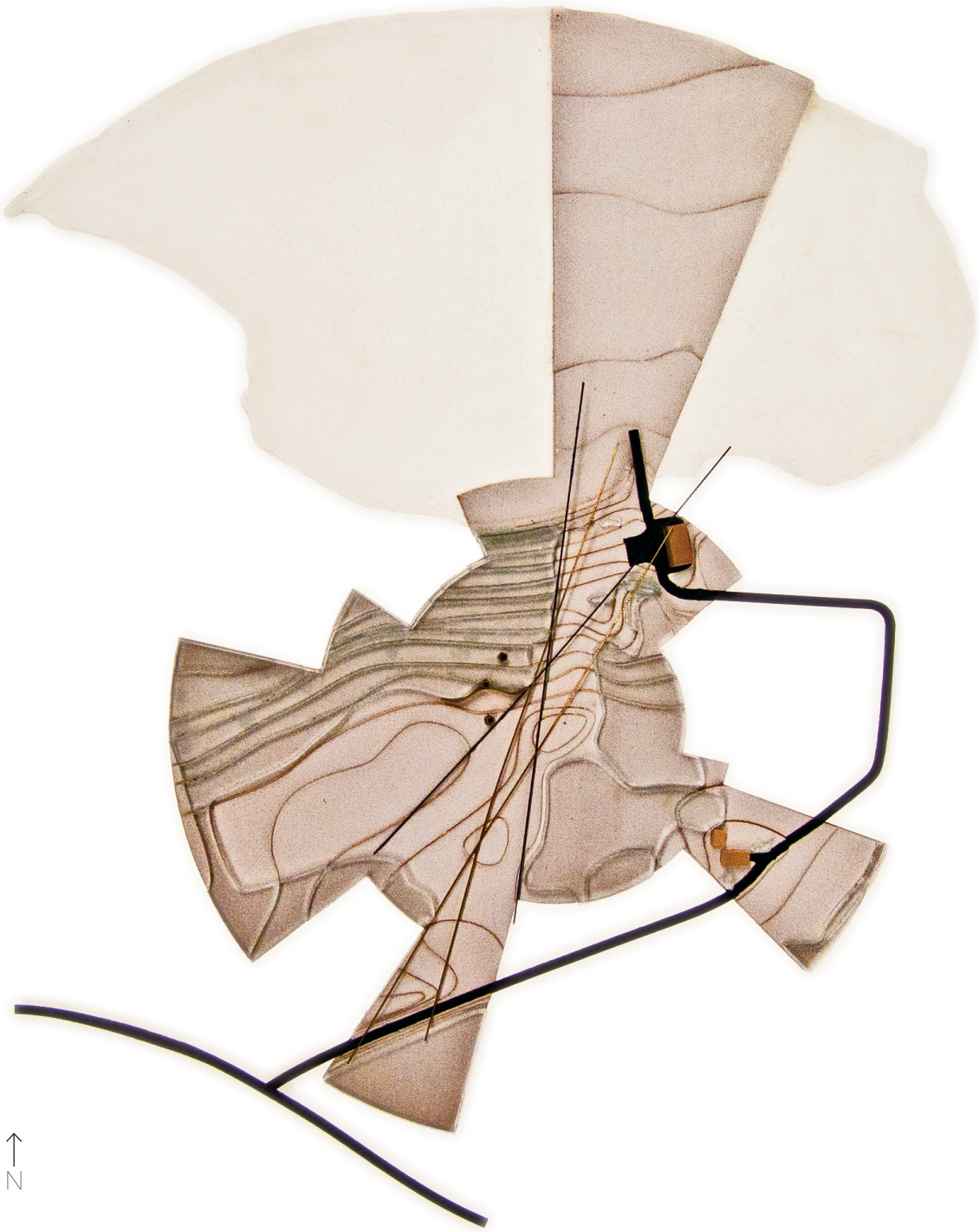
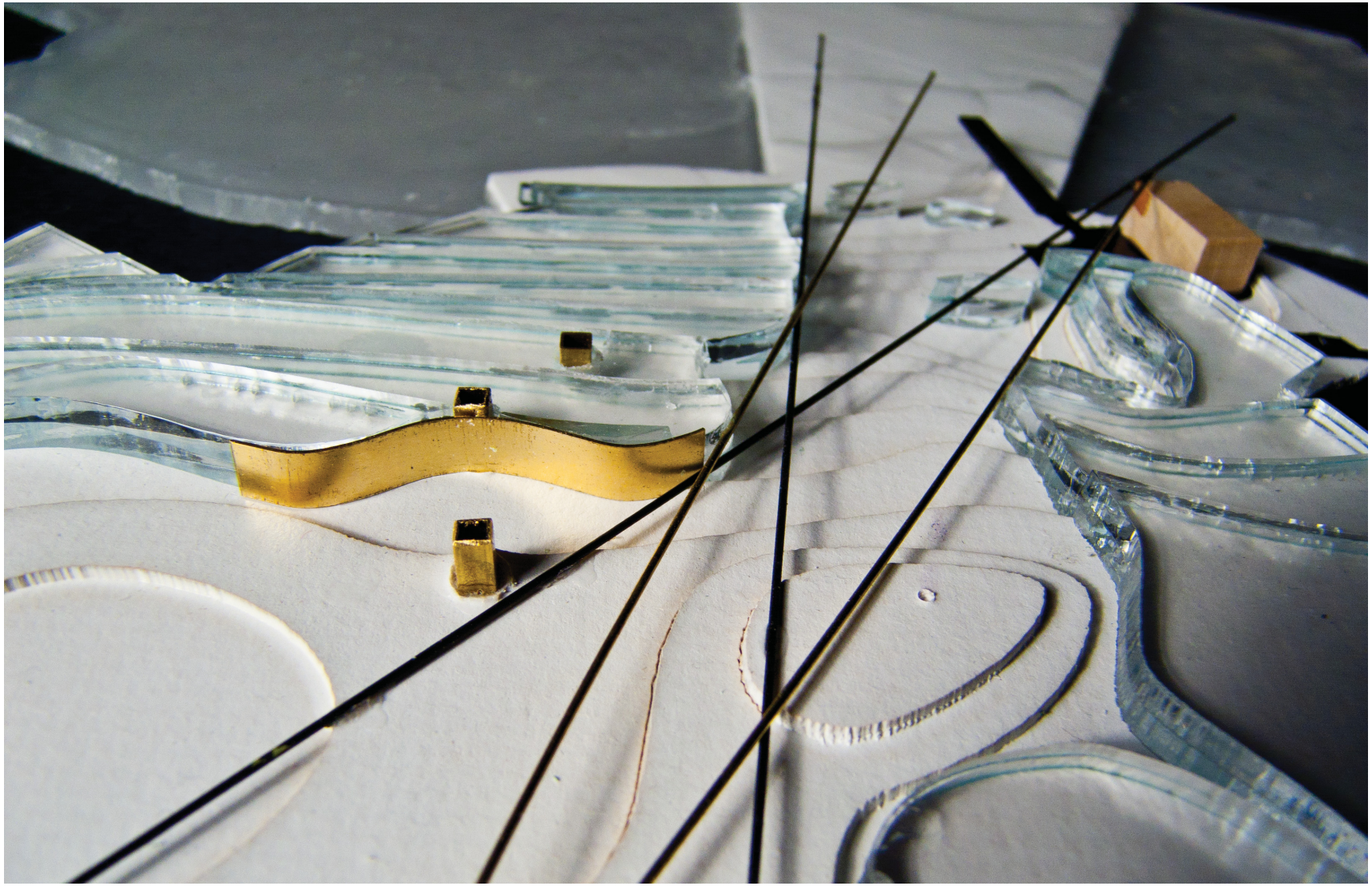
Aerial Photo showing the site in the bottom with major view planes mapped over



Site Model with key views and roadway access(water located to the north)



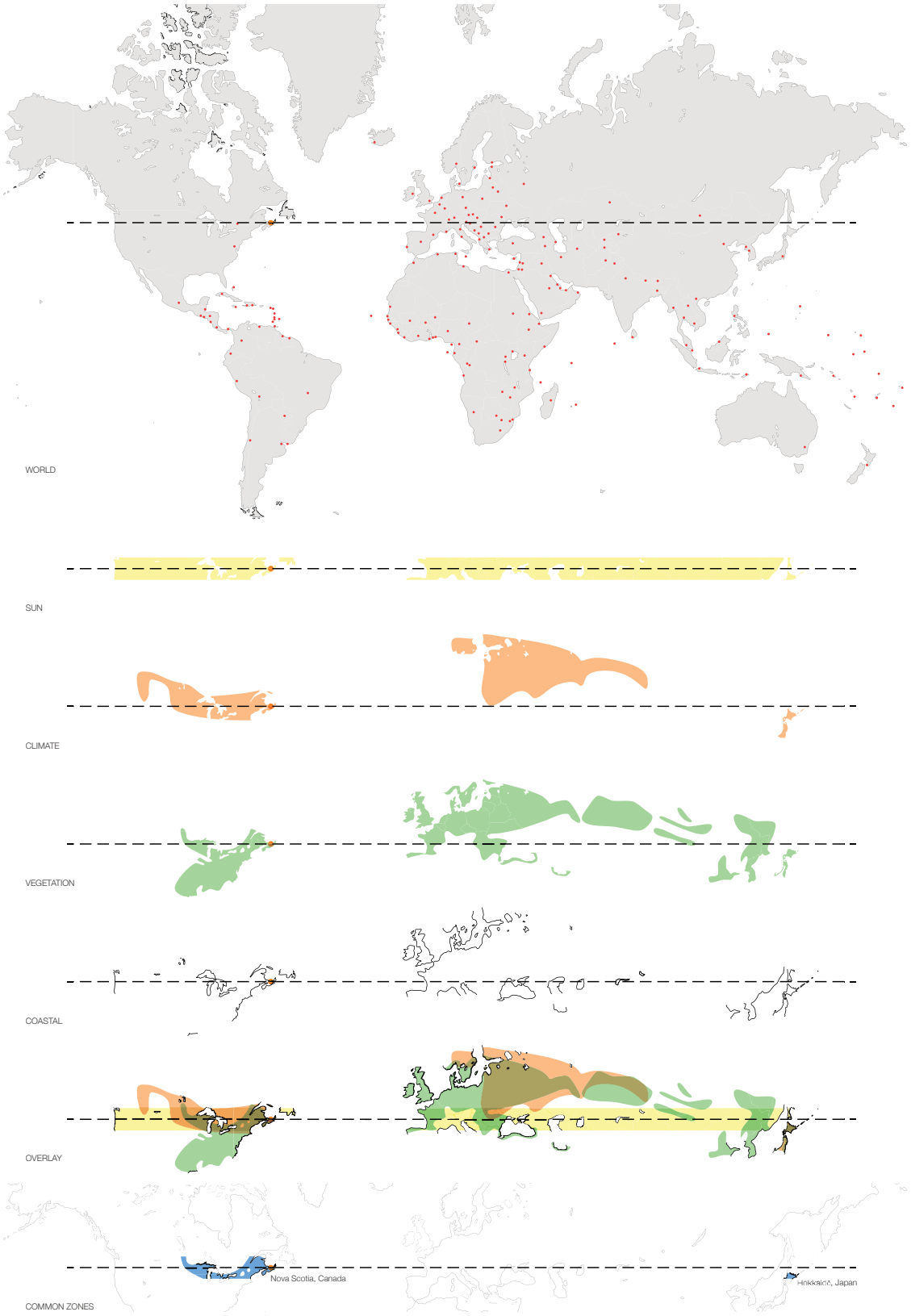
Close up of site model showing major view planes in relation to building siting.

a storage shed to the north west of the residence. It was built much later than the first building. The site has approximately 200m of waterfront, areas of forest, vast meadow, and a significant bog. The site rises to approximately 16m from sea level, which is also the elevation of the existing residence. There is road access to the site from the west and it splits the site in half. This road also feeds a series of 32 condos which are visible from the eastern portion of the site.

A site such as this one in the 19th century, would have been home to a multi-generational family living in harmony with the land in the main farm house with several out buildings for the various needs of a farmstead. The relationship between this program and that of an artist retreat are quite similar. There are buildings for work, sleep, and service. There is the will to separate these daily rituals due to noise, scent, privacy, or social separation much like those of a farmstead.

The site has a clear relationship to its immediate surroundings, but it also has an array of relationships which go well beyond this region and cover an area which circles the earth. These regions more often than not, relate closely with the latitude but sometimes stretch as far as 18º in latitude from here to 63º north.

These various regions are those which can be seen in an illustration on the following page. First mapped out individually, and then again at the bottom as an overlay. The final blue graphic shows the areas which are common to all of the factors above. This region in the world grows ever smaller, where design in a similar fashion in terms of natural elements to just two regions, Nova Scotia, Canada and Hokkaido, Japan. Unfortunately in terms of building tradition, we should consider cultural boundaries which would eliminate Hokkaido from the graphic. This



Map of major natural conditions found in Caribou Harbour, Nova Scotia.

graphic illustrates that every region has had its unique building style and relationship to the landscape. One which we must try to build on for years to come.

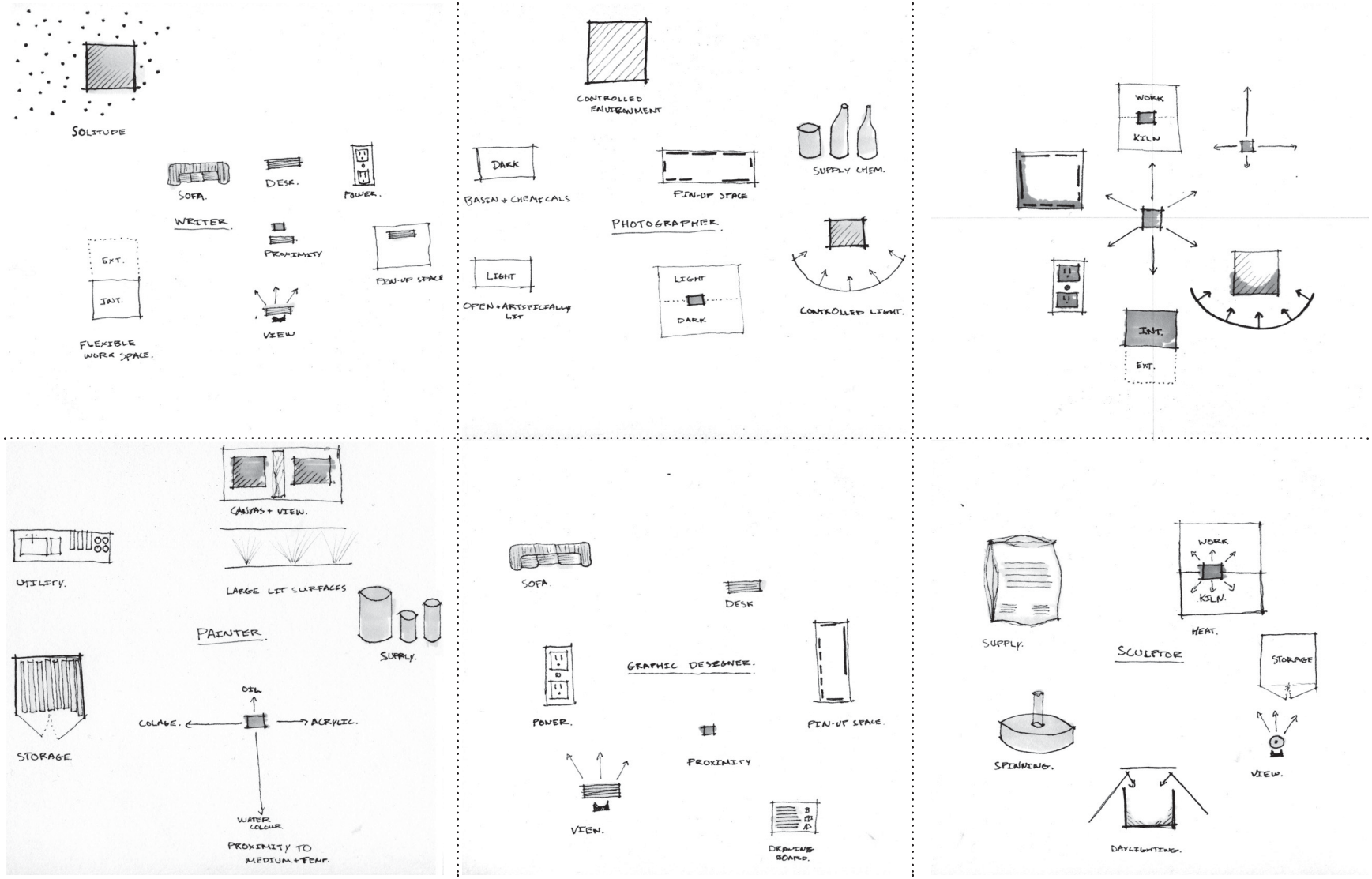
Client

Katherine Knight and David Craig have a dream to retire from teaching and build a local artists' retreat much like the one built by famous landscape artist Donald Judd in Marfa, Texas or the more similar/local example, the Banff Institute of the arts in Alberta. Their desire stems from Katherine's passion for the arts. As an Associate Professor in the Department of Visual Art at York University in Toronto, Ontario, Katherine along with Craig have a love of the Nova Scotia rural environment. Their love for this landscape is what motivated them to spend their summers in Caribou, and inspire them to create the retreat.

Program

The program is a vessel for the execution of a research base outlined above. This program could be any one of various functions, to be carried through the design process to execute the research. Understanding this as a design research approach, is very important in that we must not let the program trump the research, but rather work as a variable along with the research.

The general program for the scope of this thesis is a series of finely tuned spaces each for a specific artist user group. Both work and exhibition space for fine arts are highly particular, requiring a balance between direct light and diffused day lighting or artificial light. Historically in many rural settlements, the program will be broken into a series of out buildings, each having a sole function. This is because each function has an individual criteria of light, water, air, and temperature. For an artist retreat this is very much the case. Each artist has a series of tools



Sketches of the main artist types considered as user of the Studio.

and resources required to execute their work. These resources are sometimes scented or toxic, making it essential for physical separation.

Artist Type

There are a number of artists who have been considered, as the focus for this thesis. The following page has a series of sketches which represent five main types of artists who all have different needs not only within the studio, but also externally from the land.

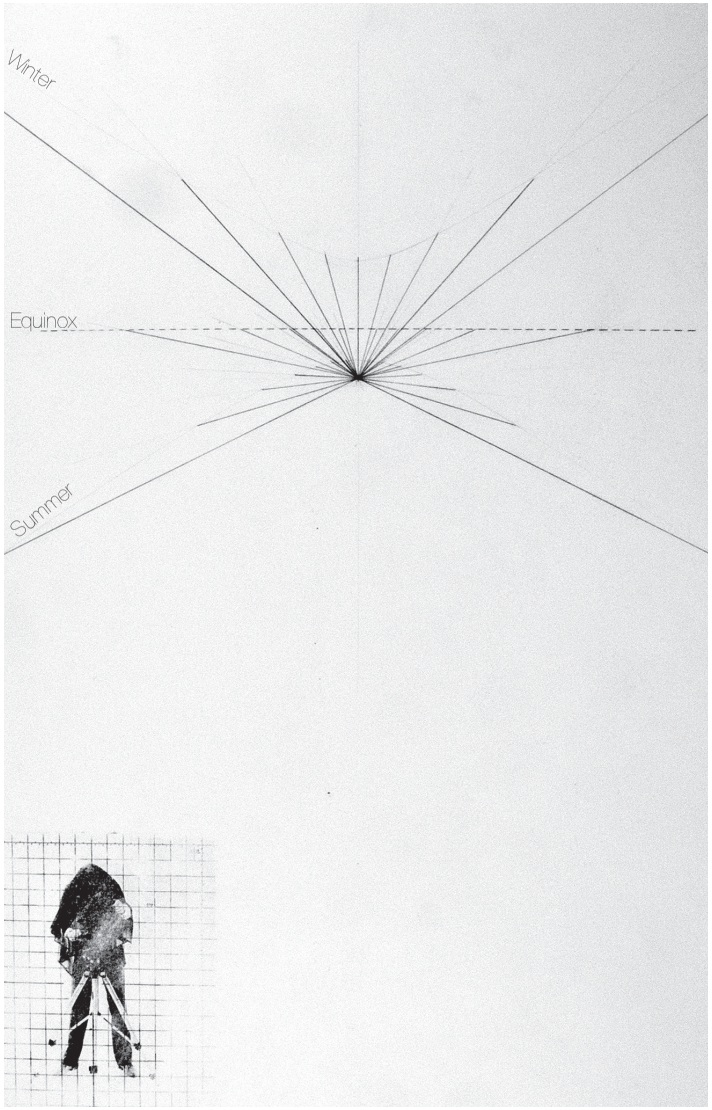
These main types are: writer, painter, photographer, graphic designer, and sculptor. Each of them have a relationship with the land and the built environment. Some require total darkness and to be shut out from their surroundings, others wish to have a space which can reflect the landscape.

The decision to design for a photographer, was made due to the fact that they have the most concrete relationship with the landscape on a daily basis. One which requires them to interact daily in order to create. They also require a very unique space which is extremely light sensitive for developing photography.

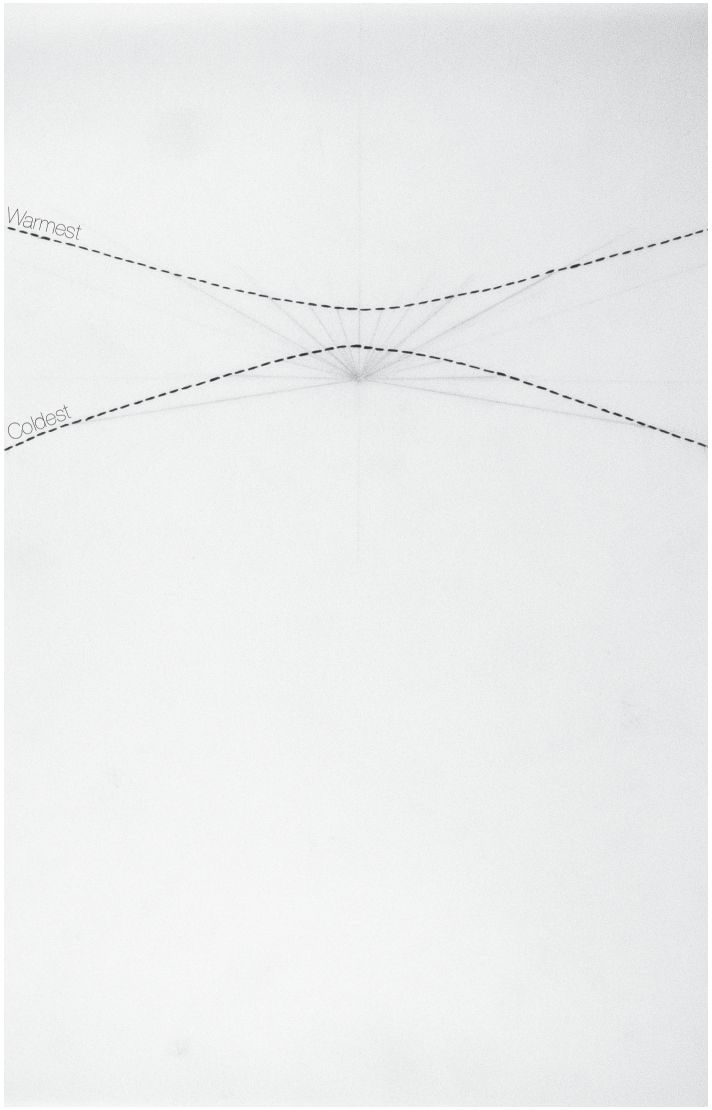
Artist as Individual

The photographer will be the subject for the studio and adjacent living quarters. There are a series of parameters which we must take into account, when designing for any individual who will be occupying the space for a significant length of time. These parameters are based on human comfort and their ability to focus while occupying the space.

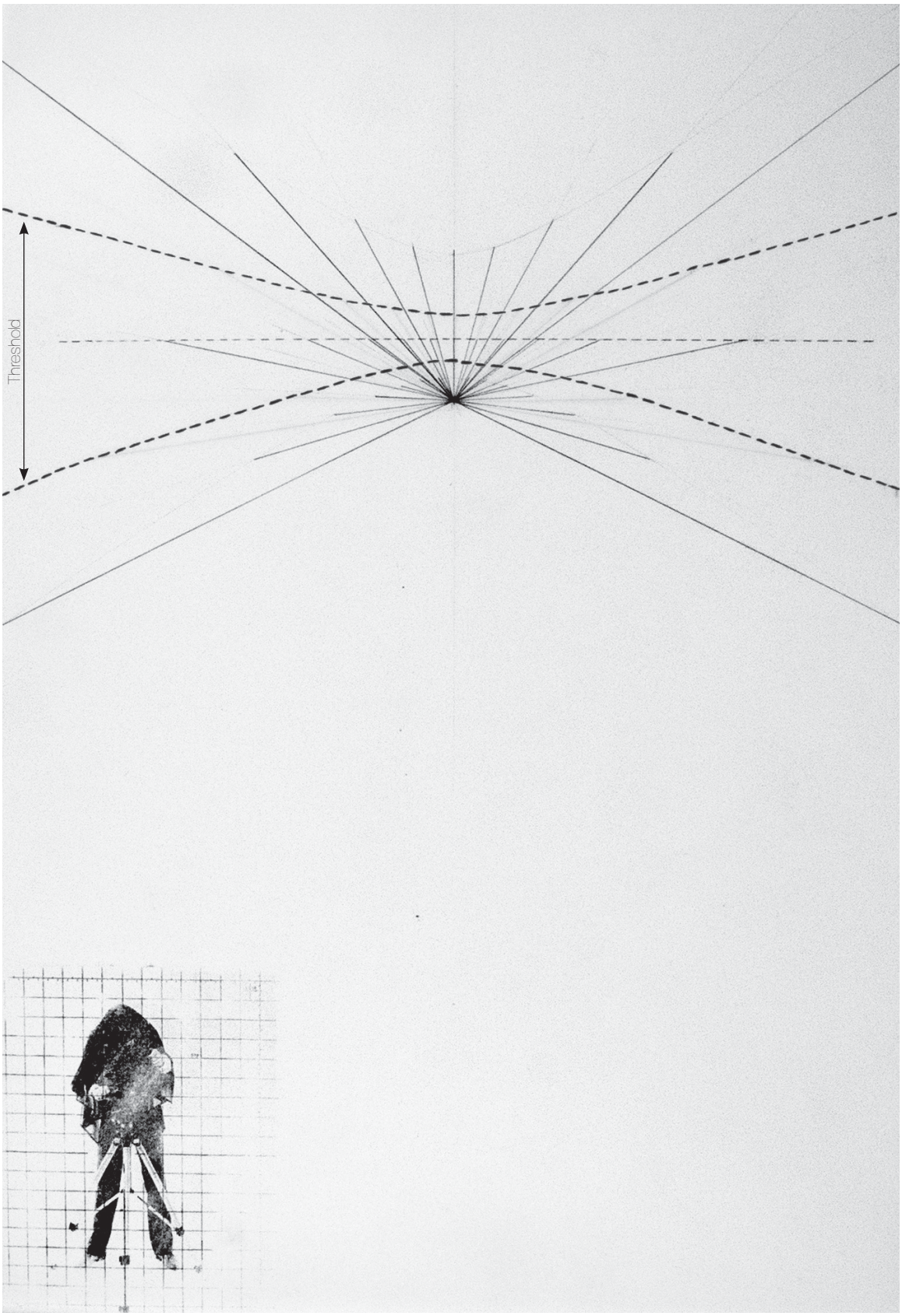
The following series of drawings represent the photographer unsheltered in the landscape. The first depicts the shadows one would cast while standing unprotected in the landscape. There is a threshold shown by the hidden line which signifies the mo-



Drawing showing the shadow one casts unprotected in the landscape



Drawing showing ones thermal relationship to the sun in relation



Drawing showing the overlay of the previous two pieces of data

ment at which the solar year passes the equinox. This represents the point when the shadows go from being longer at solar noon than the height of the human body, to shorter for the 6 months of summer. The other two thresholds are less apparent but they depict the solstice. This is the moment when the light begins to change its path from lengthening days to shortening days.

The second drawing looks beyond our celestial relationship with the sun and represents the thermal relationship of the sun to the body. This illustrates two new thresholds. These thresholds illustrate the moments at which the body feels the shift from air warming daily, to the beginning of a cooling process which will last 6 months until the next threshold. What this tells us as architects is that we need to consider the moment when the human body is most affected. These generally tend to be based around human comfort, and not solar cycles or phases of the moon.

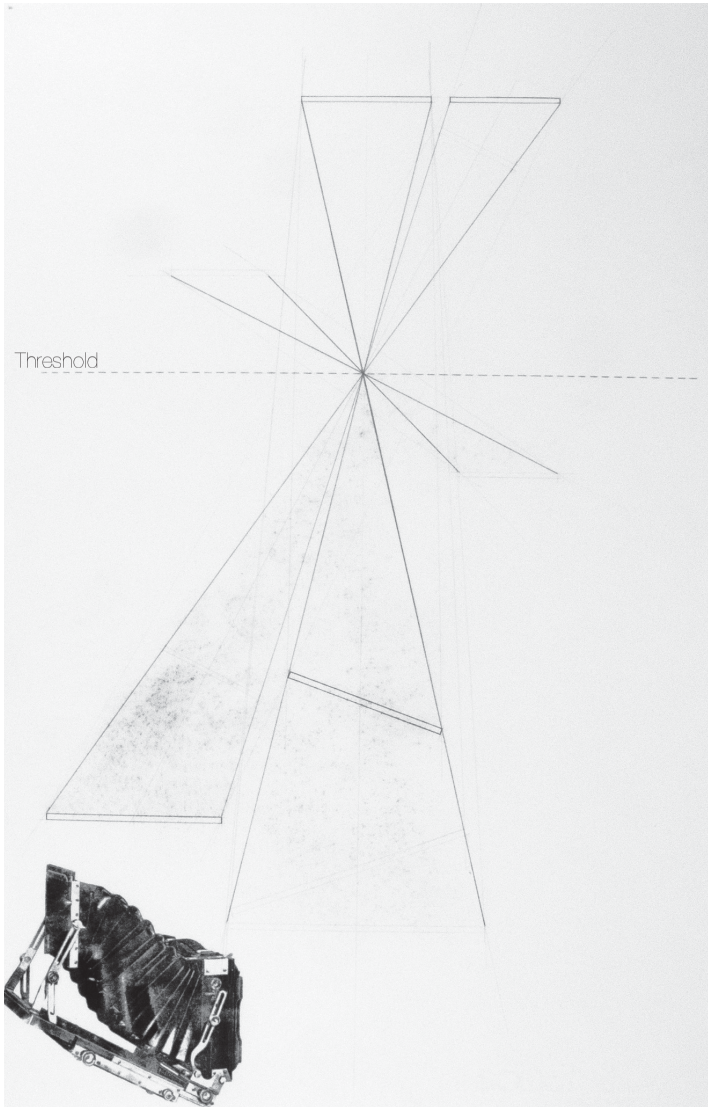
The Photographer

The artist who will be the focus of this thesis will be the photographer. The photographer has a unique relationship with the landscape, in that he/she physically interacts on a daily basis with the land, going out and capturing pieces of it, only to return to the studio and create art inspired directly from the land.

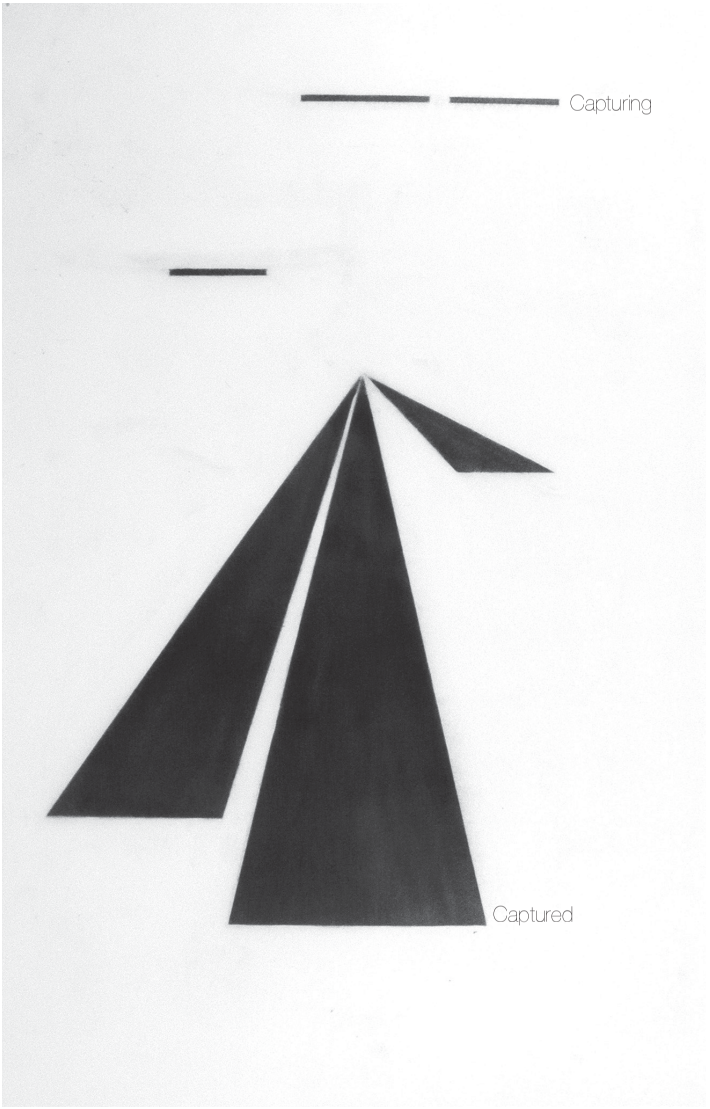
This interaction has a number of significant relationships and thresholds. The following drawings represent this, the first depicts the act of viewing the land through a lens or a glass plate camera back. There is a unique manipulation to the land that occurs when viewing where the perception of the land is mirrored in both planes to the viewer capturing the information. This transition occurs when the information passes through the camera lens and that threshold can be seen, all of the lines converge to a single point(this is represented by a hidden line).

The second drawing shows the momentary act of capturing an image. We see that the threshold proves to be a critical moment, when all data outside of the camera is significant to the result, but once you cross that line the only piece of data which has any significance is the film back itself. This is where the information is stored for developing.

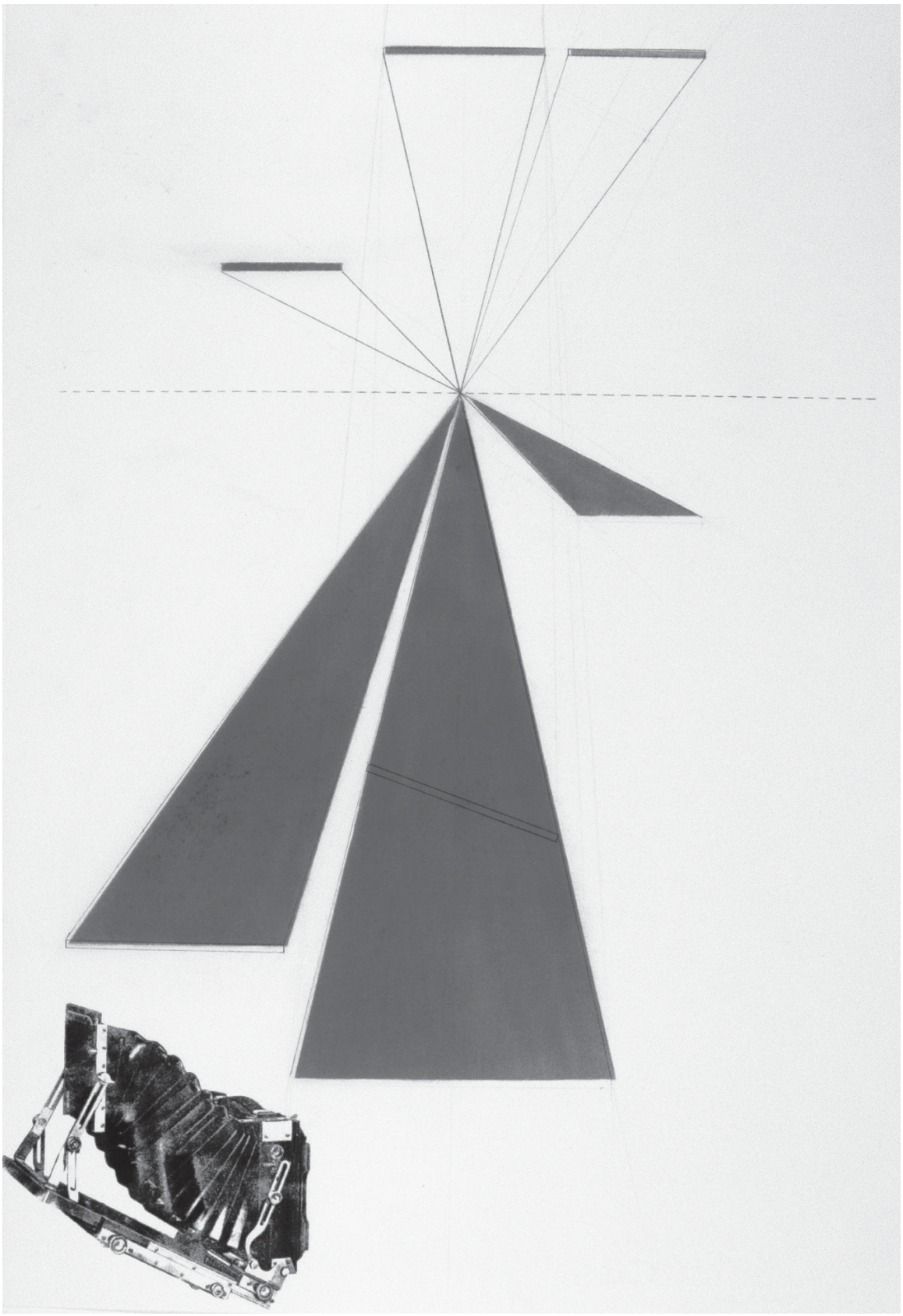
Understanding the detailed relationships of the photographer to the landscape, is critical in designing a space which allows for the execution of the process from beginning to end.



Drawing showing the thresholds a camera creates with the landscape



Drawing showing operation of capturing the landscape on film



Spacial drawing showing the overlay of the previous data

RESEARCH TOOLS

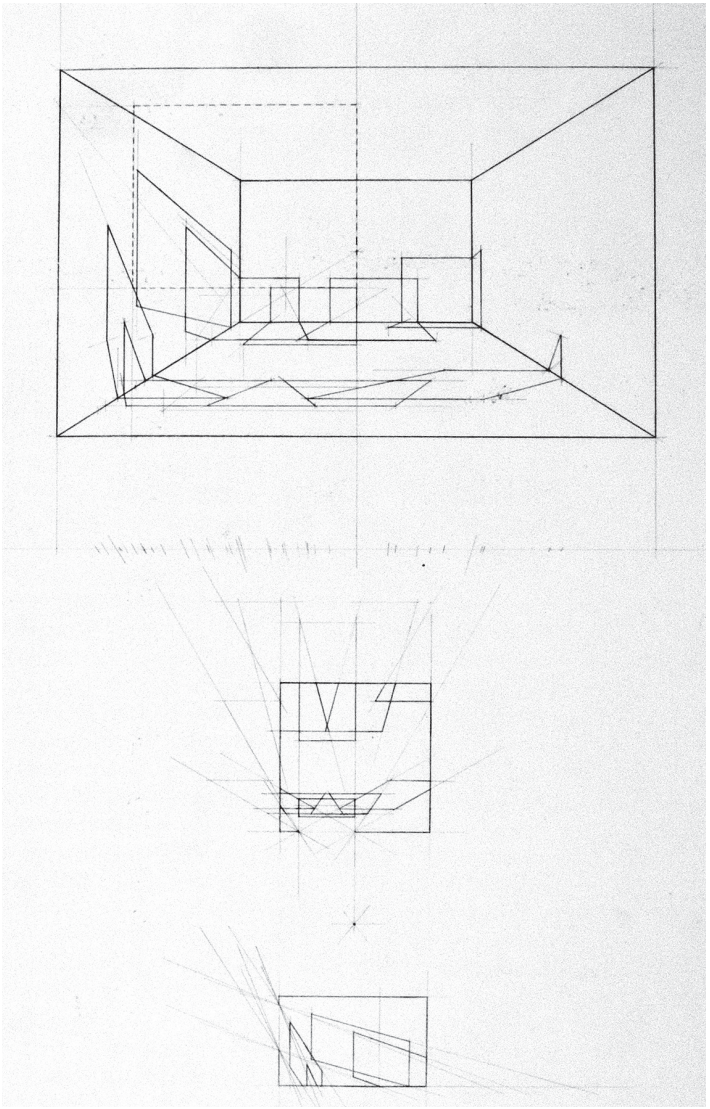
In an effort to fully understand the natural forces at play within the framework of this thesis, several key exploratory works were developed. There is a very unique relationship between the effects of light in photography and in architecture. Photographers are interested in capturing light through a lens for the sake of exposing film. Similarly architects try to capture light in a very precise way to create finely tuned spaces. These works revolve around the link between the specific design parameters set out in the previous chapter and those which begin to inform the process of design.

Mapping the sun

The sun as we have learned, travels through the sky in varying, yet consistent patterns day in and day out. In an effort to understand its solar influences on interior spaces, a collection of exploratory drawings have been made to fully understand the spacial impacts the sun has on a volume throughout the day at various times of the year. These drawings assume a latitude of 45º(that of my site).

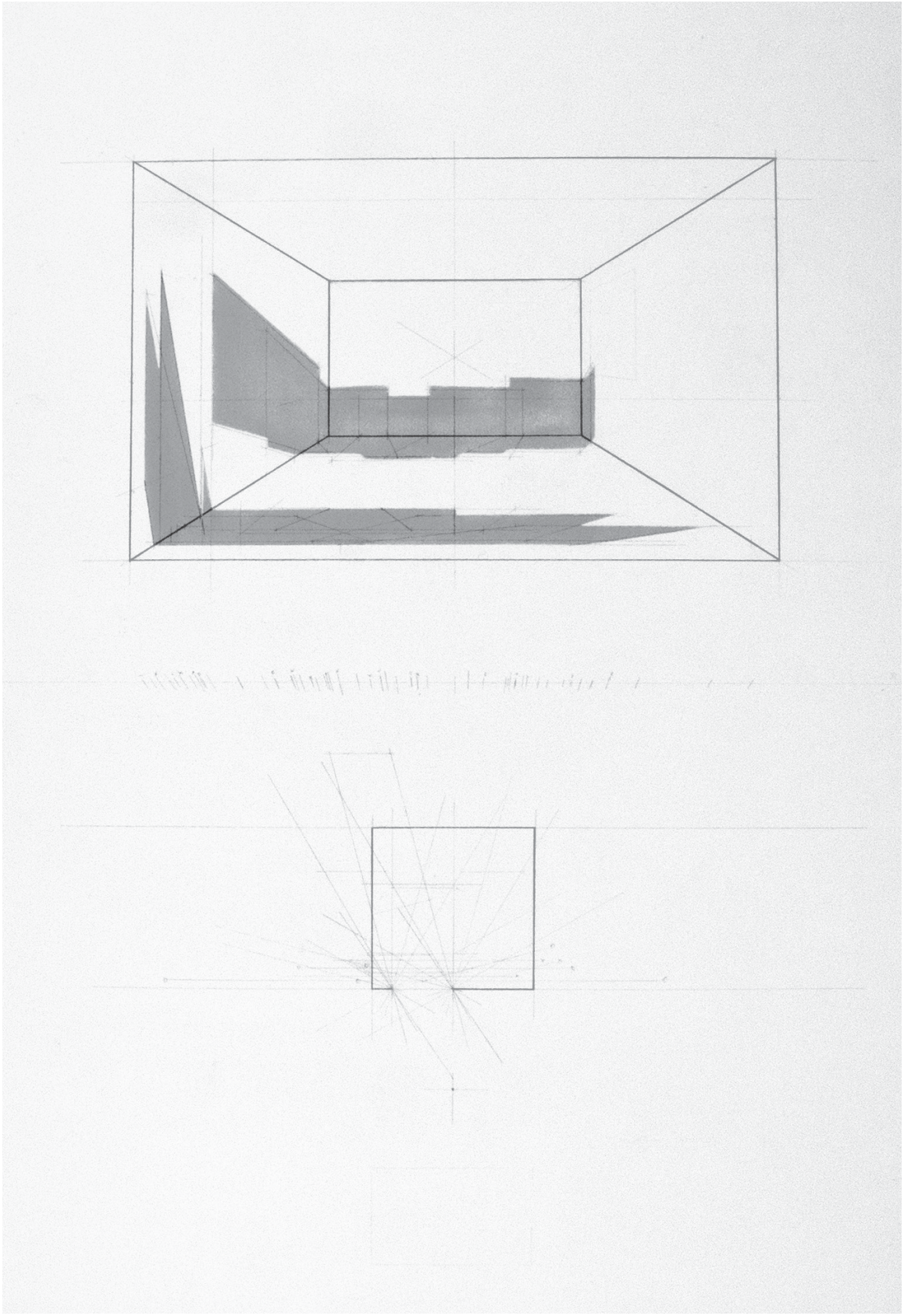
You'll find in both, a volume which is representative of a 16'x16'x10'h space with a 6'x6'(4' above the floor line) opening located left of centre on the south facing side. These two work as a series, which illustrate the depth of sun penetration in the winter months, vs. the shallow less impeding yet more potent penetrations at the peak of the solar year.

The most noteworthy piece of information to take from this, is the observation that if the depth of space is lengthened slightly, there will never be a need for absorptive materials to be located on the north facing wall. This allows for the surface to be glazed or used as a display area. If the space is shortened slightly then



Drawing representing the light penetration on an interior volume

Drawing representing the light penetration Winter/Summer

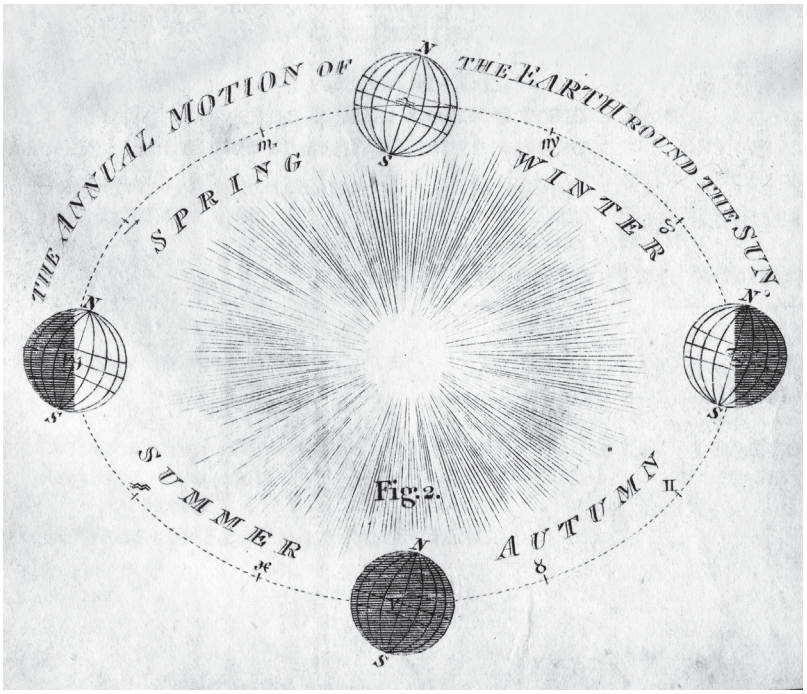


Drawing representing the light penetration Winter/Summer on an interior volume

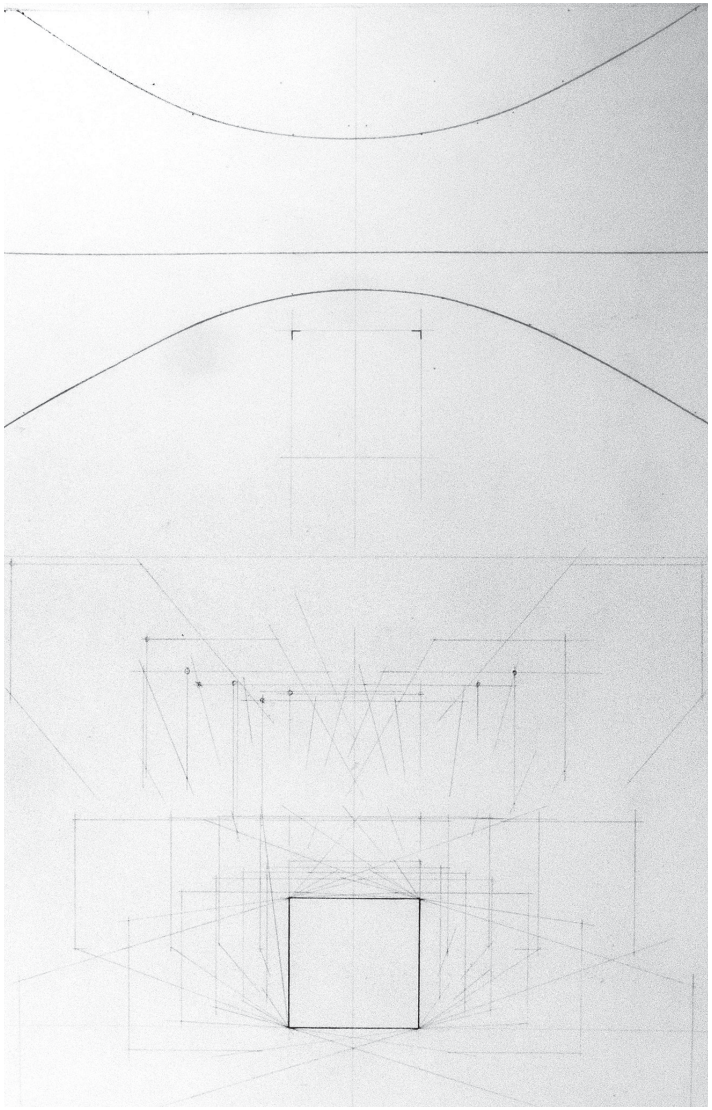
there could be a pattern which emerges, that states when the sun is casting on the north wall there is a need for thermal heat retention. When it shifts towards the floor, that need is being eliminated due to the exterior temperature rising.

These decisions, when designing spaces will allow each surface to take on a specific material quality related to its thermal needs, as a means of creating a habitable interior climate.

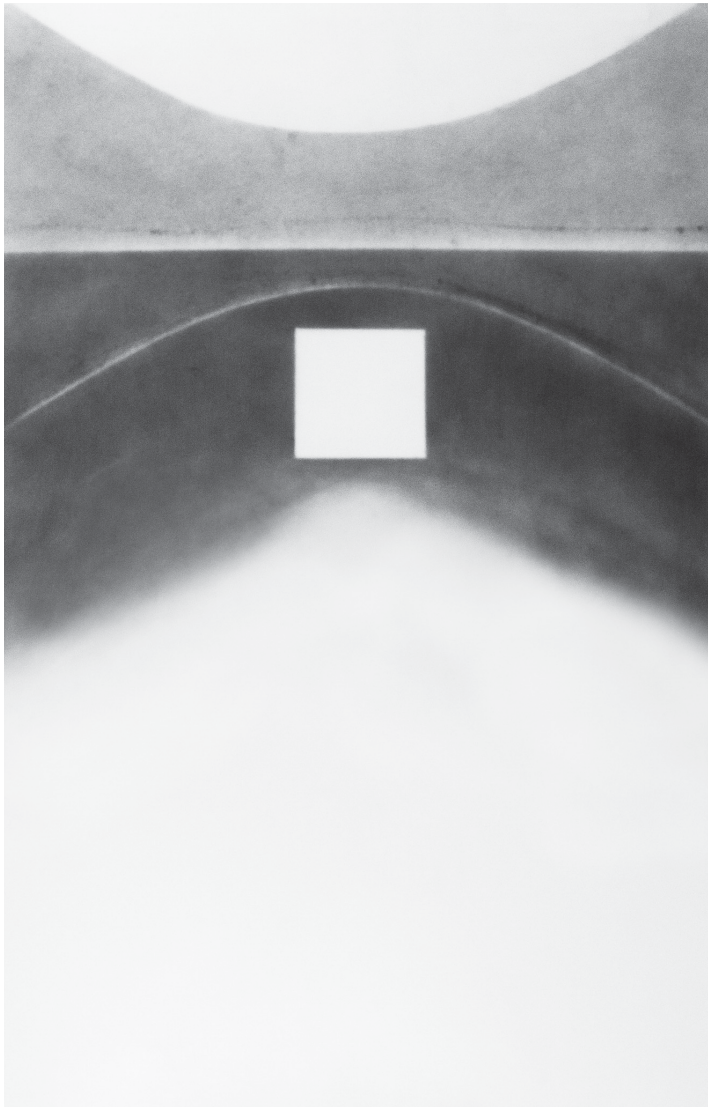
The second series looks at the exterior of this same volume, which is located on a flat unimpeded site, still at the latitude of 45º. This represents the maximum boundaries which shadows will cast over different seasons of the year. The most northerly curve shows the absolute maximum shadow length for the year at the winter solstice. The straight line running east-west, shows the shadow path at the equinox(for this latitude at solar noon, has a horizontal distance equal to the height of the casting object). Finally the curved line which runs from south west to south east, represents the shortest shadows experienced at this latitude during a solar year.



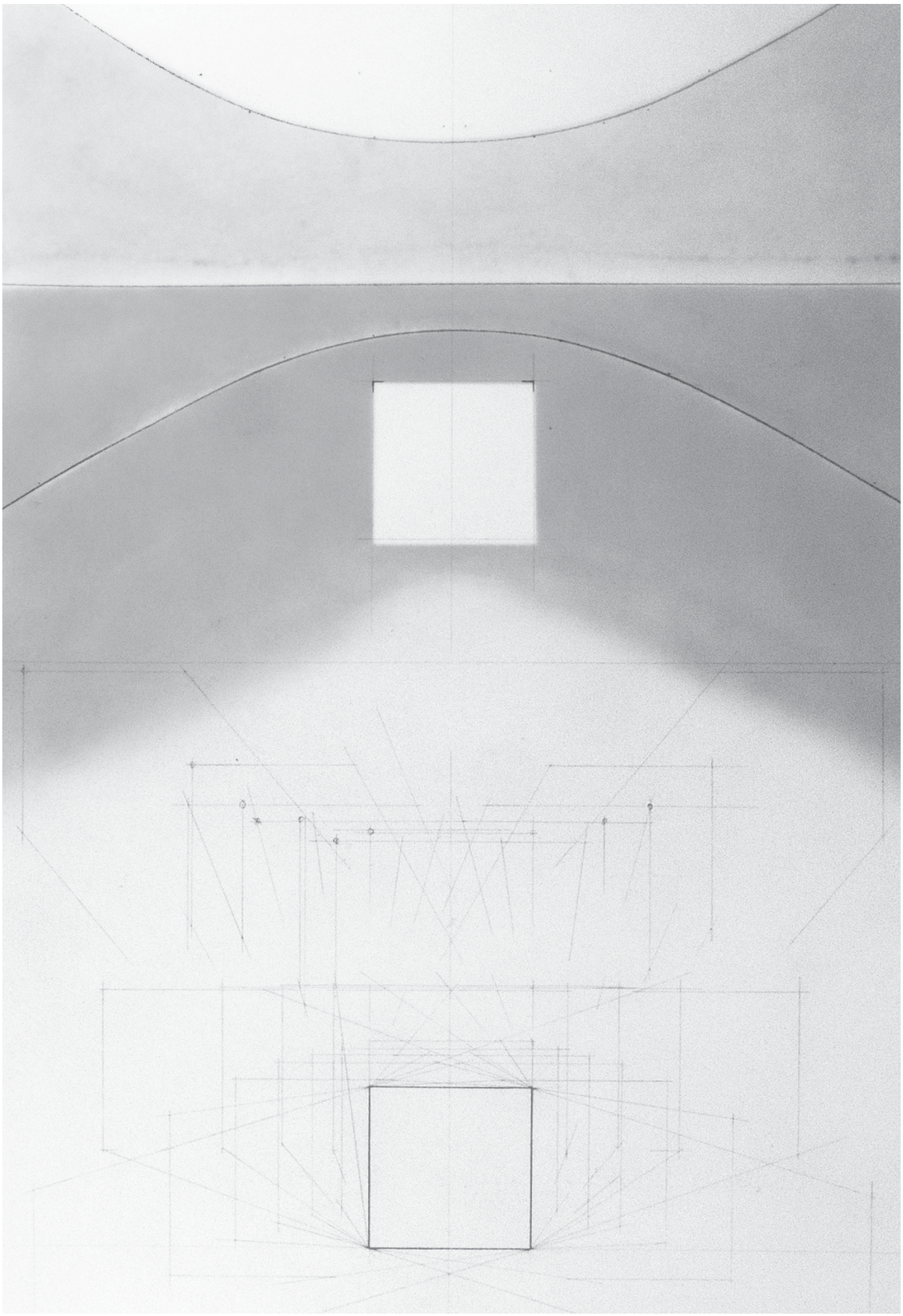
The sun path and the reasons for the shifting sun. The Complete Epitome of Practical Navigation



Drawing showing the effects of shadows on a surrounding landscape

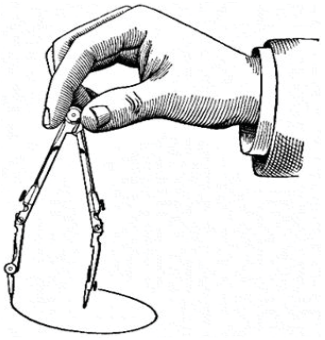


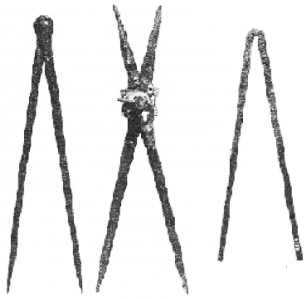
Drawing showing the strength of shadows on a surrounding landscape



Spacial drawing showing the overlay of the previous data

Each of these lines tells a story about the activity one can expect to achieve on the exterior of a building. These shadows not only represent spaces without direct sunlight, they also represent spaces which for most days of the year in this climate are uninhabitable for an inactive human being. We rely on direct sunlight for radiant heat in this region, not only in winter but for the majority of the summer. Understanding that the south face is the only one which can expect to see that sunlight day in and day out is key to the success of an exterior room.





Top: Compass drawing circle

Bottom: Greek drawing tools. Reading The Past Mathematics And Measurement

Mapping Device

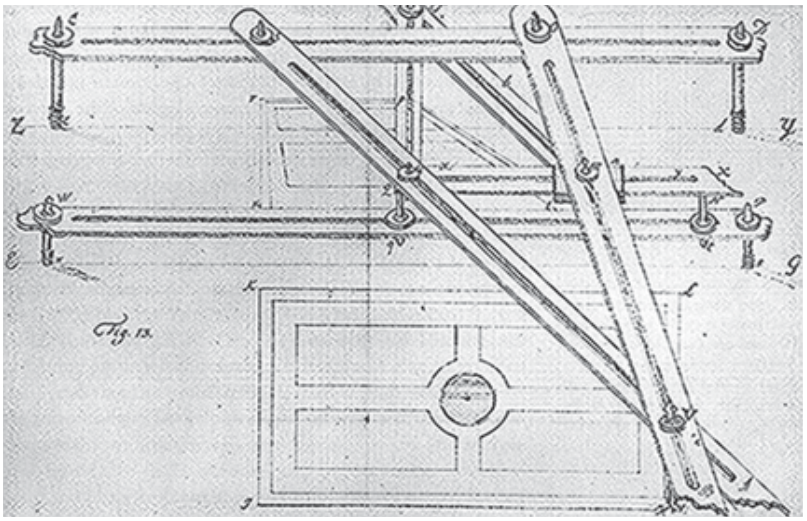
The act of reproducing factual data is one which people have been executing in various means of efficiency and complexity for centuries. Humans have a great desire to simplify tasks which are repetitive, factual, or otherwise mechanically capable.

Compass

The Compass used most widely for the reproduction of circles and arcs was first developed by the Greeks before the 7th century. Their collection included calipers for measuring, arc and circle drawing devices. These tools were monumental in the application of geometry on architecture.

Pantograph

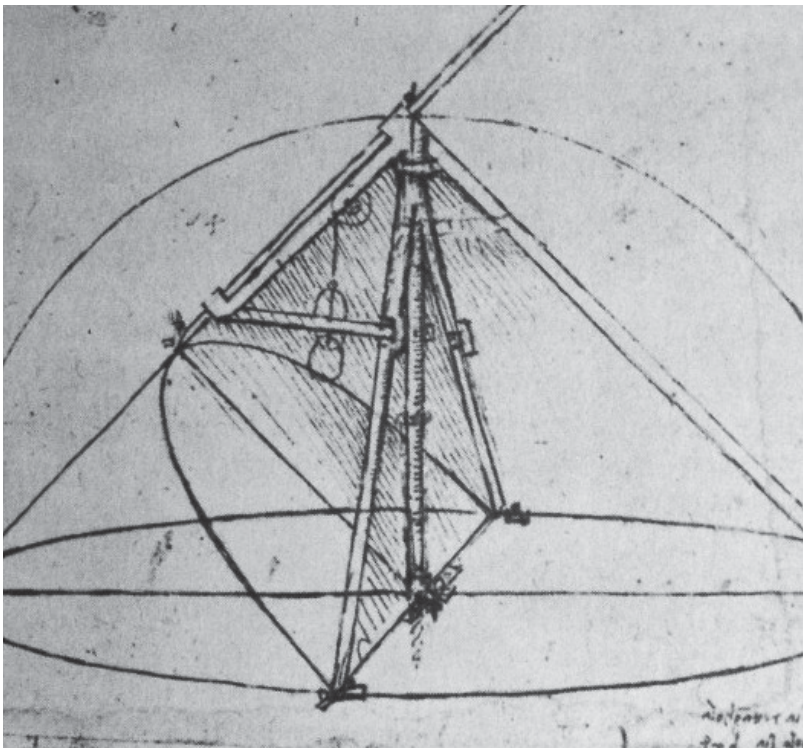
Christoph Scheiner first constructed a Pantograph in 1603. He used the device to copy and scale diagrams. This device is very simply based on a series of parallelograms, which can be adjusted to reproduce images at various scales from an original. The pantograph is a very good example of a mechanical operation which can manipulate data. Its design allows it to be erect on a drawing table with a base point for reference and accuracy. These are essential features in a drawing device.



Lambert's modified pantograph. Architectural representation and the perspective hinge.

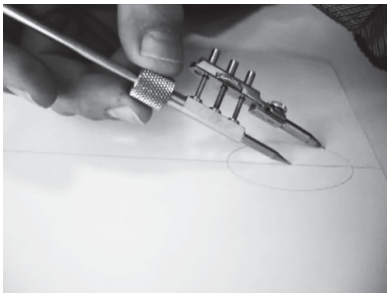
Parabolic and Elliptical

There have been several attempts to create devices which resemble a compass(which can only draw circles or sections of a circle) to draw ellipses, arcs, parabolas and other forms of curved lines. The first is this sketch by Leonardo Da Vinci who designed a parabolic compass. There are elements which have clearly been drawn from the Greeks' circle compass and others which are drawn from the geometry of a parabola.The last is a



Parabolic Compass, Leonardo Da Vinci, 1408. The life & times of Leonardo

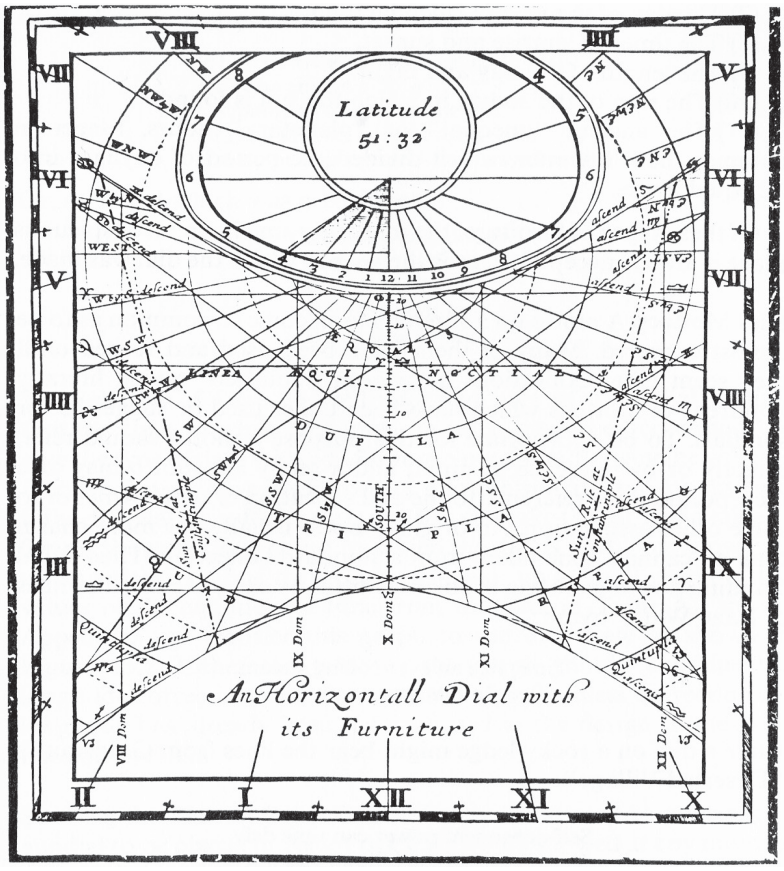
modern day ellipse compass and a parabola compass. Both were designed, prototyped and patented by Khosrow Sadeghi.

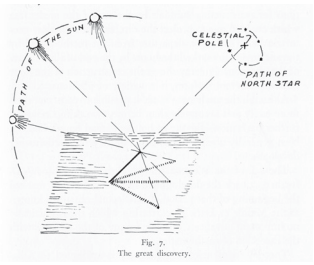


Left: Elliptical Compass
Right: Parabolic Compass
(By: Khosrow Sadeghi)

Sundial

There are also a variety of ways to map the path of the sun in real time. Most of these methods focus on the location which a gnomon casts its shadows. These devices are generally static, allowing the sun to travel around them. The image on the right shows the basic composition of the sundial. It can simply be achieved by placing an object pointing towards the celestial





Above: The Great Discovery. Sundials: How to Know, Use and Make Them

Left: Horizontal Sundial with an array of Dial Furniture. Sundials: Their Theory and Construction

Pole at an angle to the Horizon equal to its latitude. The second image displays the more complex arrangement of the sundial. This Horizontal dial displays an array of data including shadow length, the sun's altitude, the length of the day, sunrise and sunset, and the latitude. These devices are used as an account of a series of factual data for others to see and understand. This sort of mapping is essential to the knowledge of natural conditions which are all around us day in and day out.

First mapping device

Mapping the Sun

The sun as we have discussed is critical in all architectural design. Knowing how it interacts with the site and the natural landscape, is critical in understanding the effect it might have on your building. Furthermore, knowing how the building will affect the site is much like the earlier drawings, which describe the shadow length and angles for all seasons of the year.

Second mapping device

The following series of devices have been designed in a linear fashion, developing on all of the research to this point with regards to the movements of the sun and their effects on architecture. The attempt is to create a device, much like the ones seen previously, that can assist in a fast and mechanical manner the making of a drawing at scale; to produce a series of data-based images on a certain topic. In this case, the data is the sun and shadow paths created by an architectural or natural element.

Third mapping device

The first four attempts were each successful in their own right. The first was only capable of drawing a straight line, the second drew the paths but with incorrect Latitude. The third, was of course the most successful to this point, performing all of the operations correctly, although not manufactured to a level which made it functional, with settings for latitude, time of year, and time of day. The issues which arose from this device, was its inability to scale itself to match that on paper.

Fourth mapping device

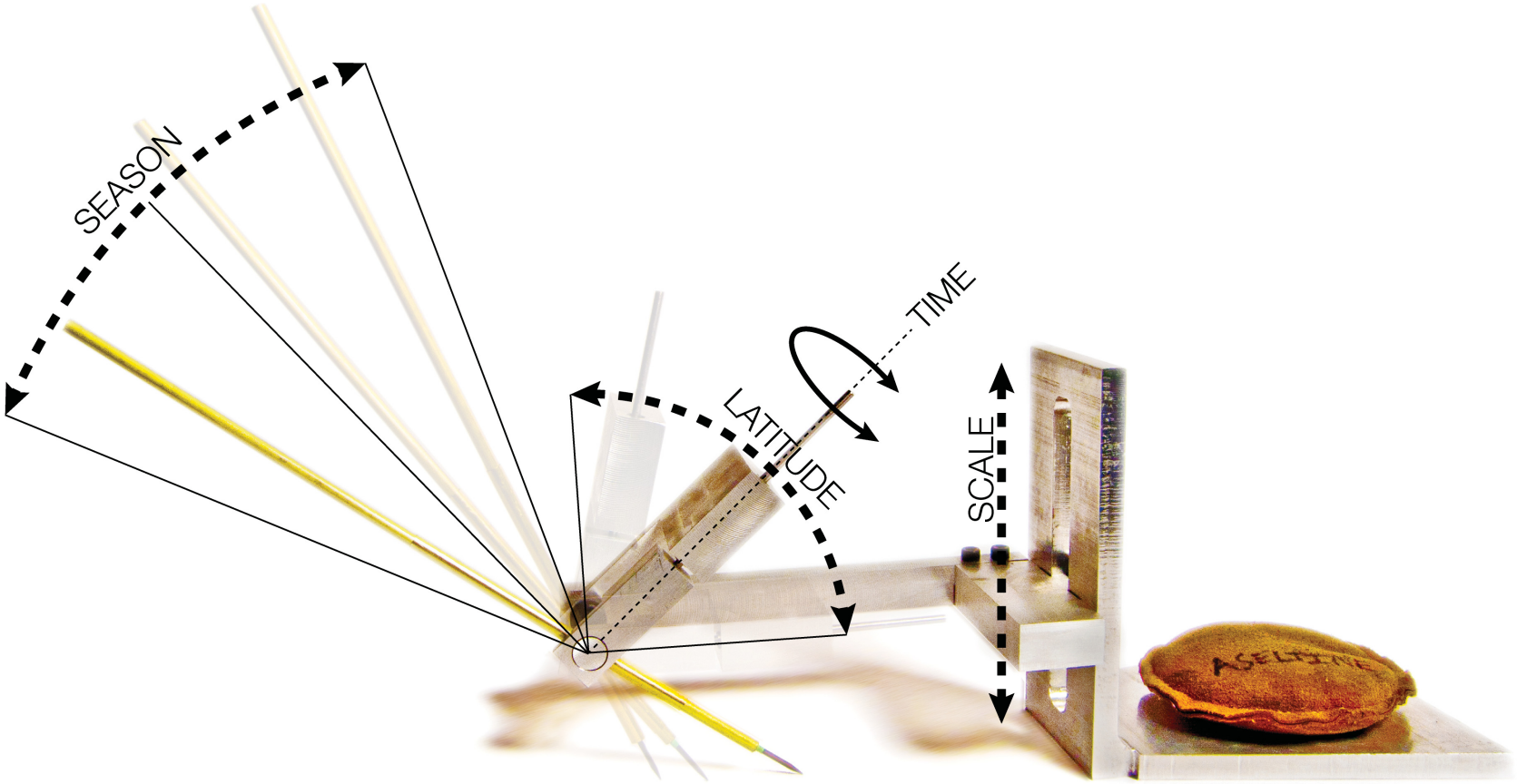


Image of sun mapping device showing its various adjustments

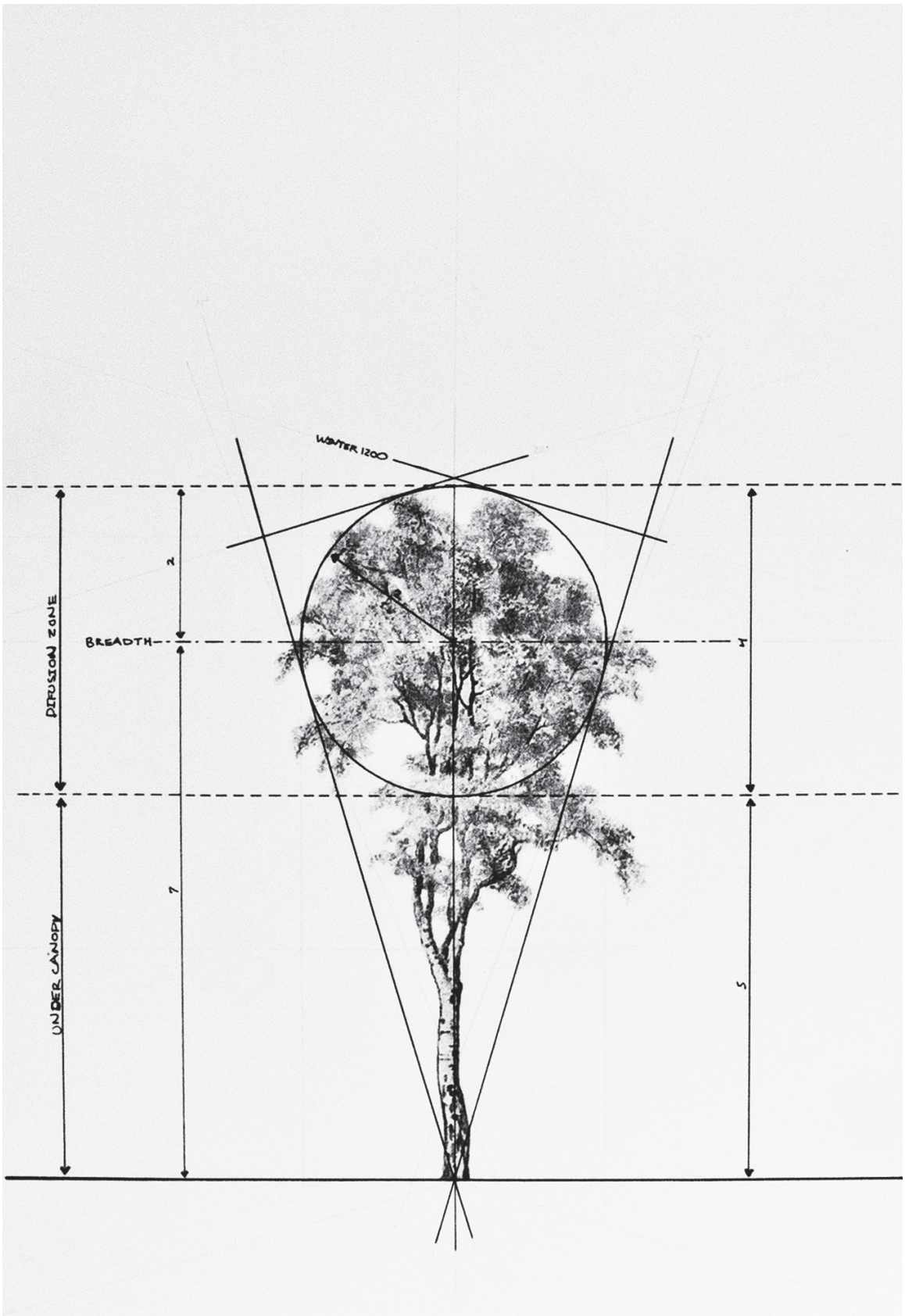
The last of the sequence of devices can be seen as a prototype first, and then completed as shown on the previous page. It encompasses everything which was successful in the previous three, along with several new features which allow it to adjust up and down to match the scale of a drawing on paper. The image graphically describes the mechanics of the device, while the subtlety of each moving part is best understood while using and adjusting it.

Understanding the Forrest

The forest is key when discussing light and its relationship to architecture. The trees have numerous affect to the light penetrating the forest floor. They shade, diffuse and deflect. They can also act as a receiver of light for one to experience. Beyond the aspect of modifying light, they have their own characteristics which can be measured.

Trees much like humans, have proportions. Each species carries with it proportions which can be measured. This study will focus on the white birch(the predominant species on the site). On the following page you will see a drawing which displays the proportions of a common white birch. There are a few key points to note. The under canopy and canopy zone, are clearly defined as spaces with and without foliage. Also the breadth of the tree is equal to the hight of the canopy zone. Finally the overall conic shape of the trees foliage.

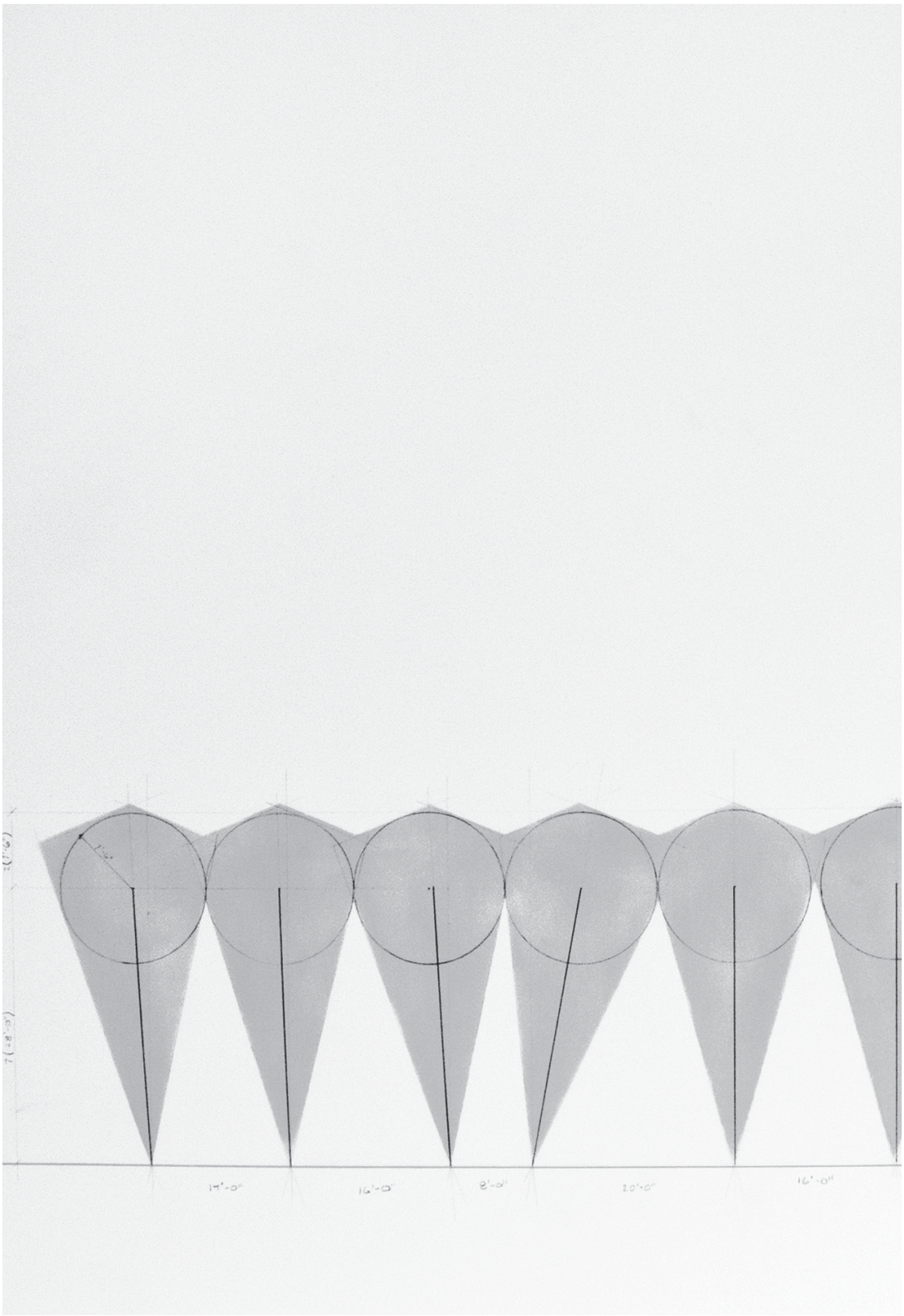
Model of tree canopy and density



Drawing showing the relative proportions of a white birch (the predominate species on the land)

Drawing showing the proportions of a birch stand

Drawing showing the volume of a birch stand



Drawing showing the overlay of the proportions and volume

DESIGN STRATEGY

The act is one which is the direct result of research, site, and programme. These are the driving forces which design must respond to, while keeping a clear balance. In this case the research has focused on the effects of light on the built form, the material qualities derived from the interaction of light and shadow.

The programme forces the architecture to have two faces; one(studio, living) that allows for the direct experience of the sun and the other(darkroom, sleeping) which attempts to shelter out the direct light and allows for a more ambient feeling. This arrangement manifests itself in the material quality of the exterior facade, along with the specific siting of each structure. The site has a vast array of conditions, which allow for the architecture to manifest itself in several ways responding to the programme individually. The following section discusses the key influences which link research and design. These include programmatic relationships, light quality, material engagement, and rituals.

Arrangement

The formal arrangement is one that derives itself from the topics discussed above. The siting in perticular is one which is very malleable in the sense that when one thing changes, there is a trickling effect that changes the other structures. Their relationship is one that relies heavily on the projection of shadows from one structure to the next. The relationship between the envelope form and the sun pattern is very clear when looking at the two structures. One which receives direct sunlight manipulates itself to best receive that light. The other can only experience the sun through dappling from the trees and therefore responds first and foremost to the building materials and programmatic use.

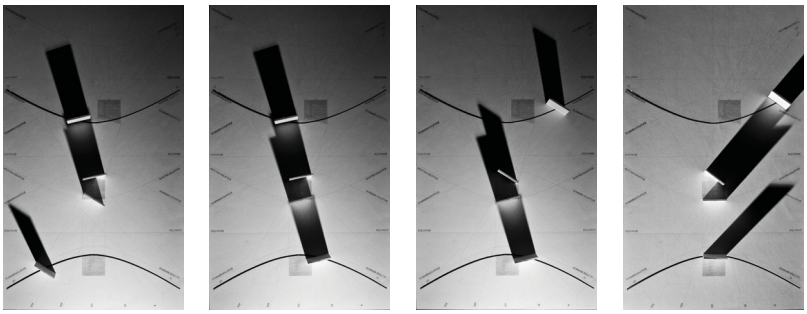


Image of the possible formal arrangements based on shadow patterns

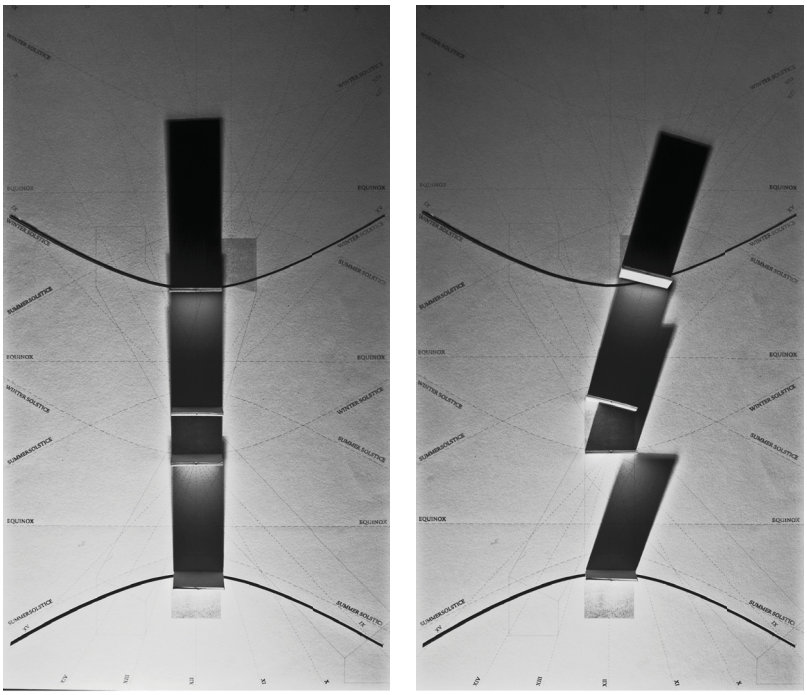
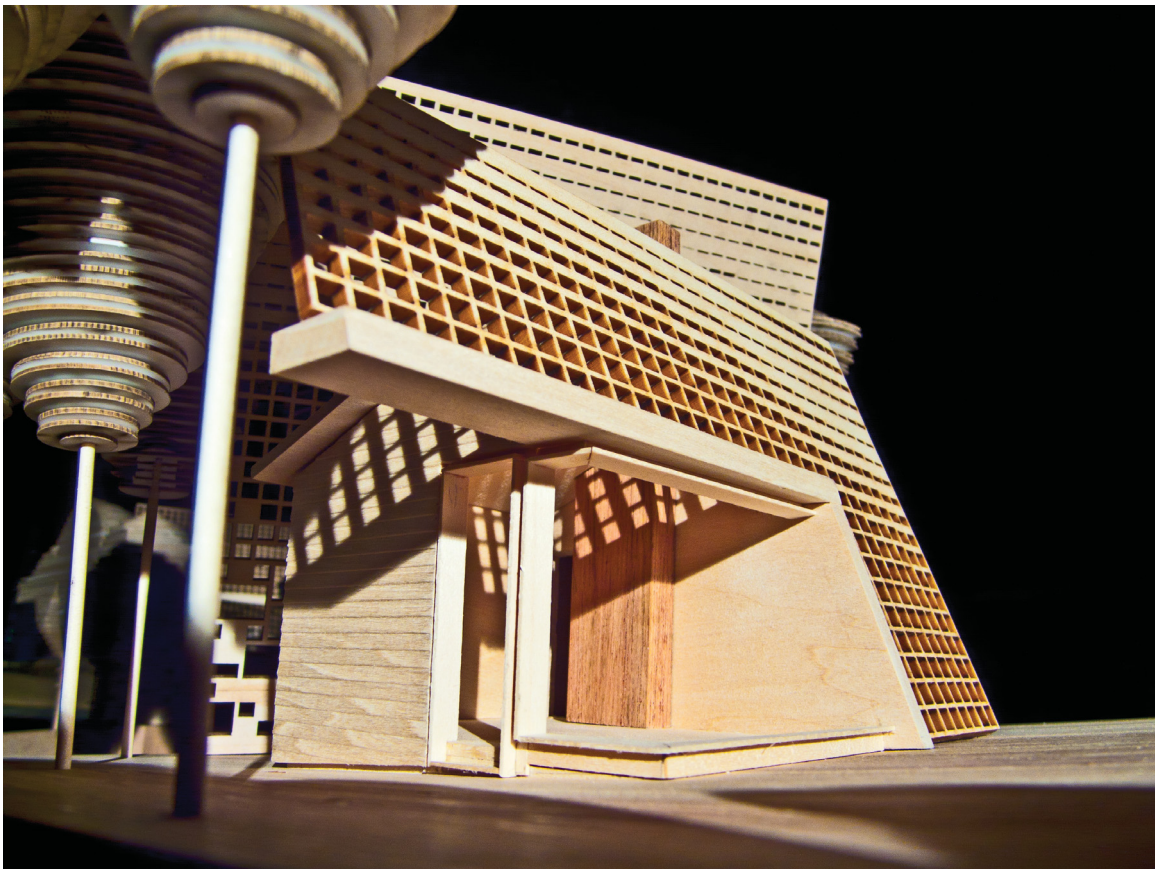


Image of the formal arrangement between the three structures

The images above, show how the movement of shadows cause the distance and angle of buildings to also move. The lower images show the arrangement in the final state. The architecture has two main elements: the structure in which the programme occurs and the devices for experiencing the light, views and thresholds. They are independent in their function, but interact formally when required by the programme.

Material and Immaterial

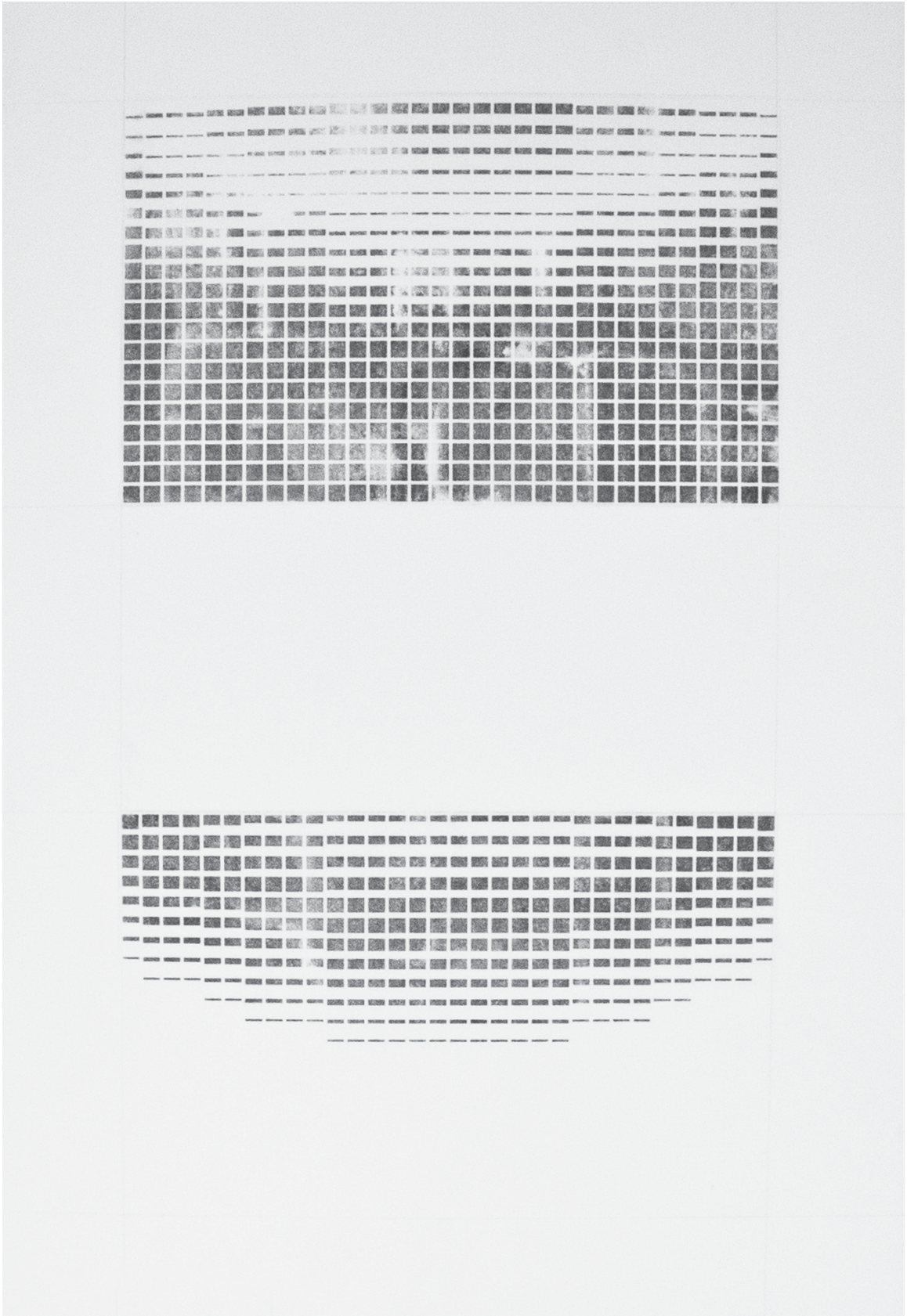
The relationship between the tangible and the experiential, are conditions which relate to this design in two ways. The first comes when the photographer is confronted with the task of capturing the immaterial qualities of shade and shadow in rela-



Model 1/4”=1’-0”
Showing the light entering through the south facade deflecting through the screen

tion to a subject. Their understanding of when the two come together is one which manifests itself in a tangible form, at the moment when the film is being developed. The film carries with it, data which allows others to understand what the photographer was experiencing at the time of the photograph. The second is when the architecture(material) and the light(immaterial) come together at a moment, this is the experience which the user is able to understand each in relation to the other.

This relationship is best understood when looking at the details that bring the patterns of the sun into the material resolution of the flooring, or the exterior screens that are designed to deflect light to the forest floor. The image above shows the relationship between deflecting light on the exterior of a building, and harvesting energy inside the building. These details are intended

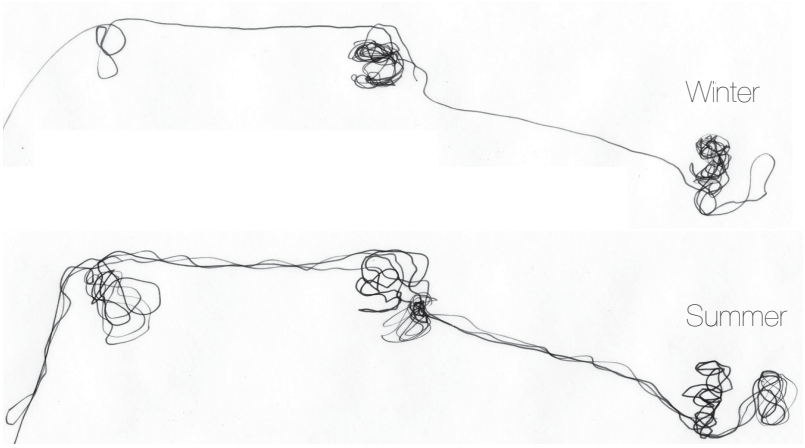


Drawing showing the solid/void left by the passing sun on various absorptive or reflective surfaces

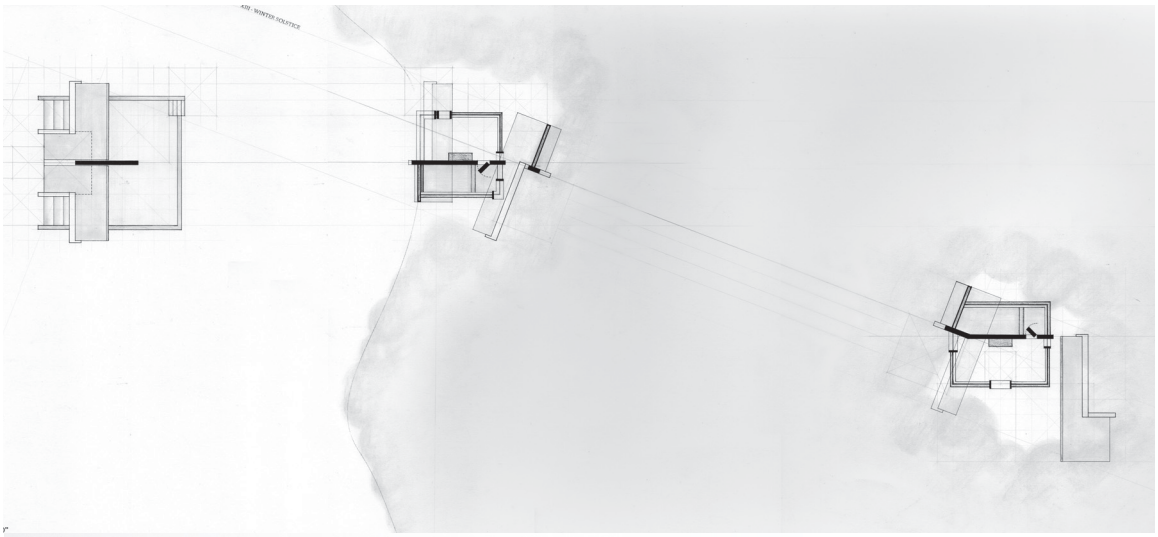
as the moment where the light can best be seen and understood by the users of the building. Their direct relationship to the quantity, quality and thermal experience with the sun is manifest here. From this, the architecture can begin to shape itself around the experience of the user. The image on the previous page shows how the movement of the sun's rays on a surface can influence the way materials are treated over a floor, wall or exterior paving surface.

Daily Ritual

The development of this design has lead itself in a way that foresees the artist interacting with the landscape, and the daily rituals of the sun. Movement through the land will occur in a similar fashion from day to day, moving from the cabin to the studio and out to the field, to the pavilion. Each artist who inhabits the spaces will begin to recognize signs in the cycles of the sun, which inform them of their movements from one structure to the next. In the field there is a pavilion designed for personal reflection and the direct understanding of the sun's movement, which manifests itself in a more abstract way through the other two structures. This daily ritual is the framework that allows the formal manifestation of the design, to express itself while keeping a grasp on the patterns of solar calibration that drives design.



Sketch of migratory patterns in summer vs. winter



Above: Plan drawing showing the various thresholds from field to forest

Left: Image of small model displaying the key thresholds

Thresholds

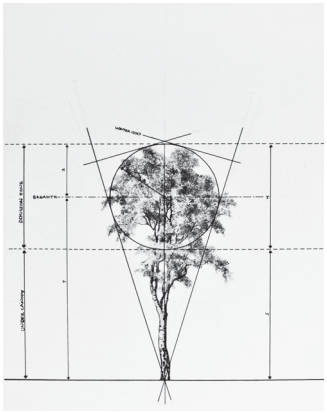
The site which has been chosen, holds with it an array of micro-climates. These microclimates shift most significantly at the moment where the field transitions to the forest. This is the threshold where the key natural conditions outlined and displayed previously on page 14 make a shift. At this point the light begins to diffuse, the vegetation changes scale and proportion from grasses to large shrubs and trees. The temperature becomes more stable from season to season, due to the insulation that the forest brings, and the humidity is higher from the moisture that the trees hold.

These are the factors which drive the programme to be located in this orientation. The more stable climate allows for a more consistent heating and cooling strategy. The reduced direct

light is good for the photographer's darkroom and studio. The thresholds are such, that it also allows the user to have an array of spacial experiences throughout one day, something a singular building could not offer.

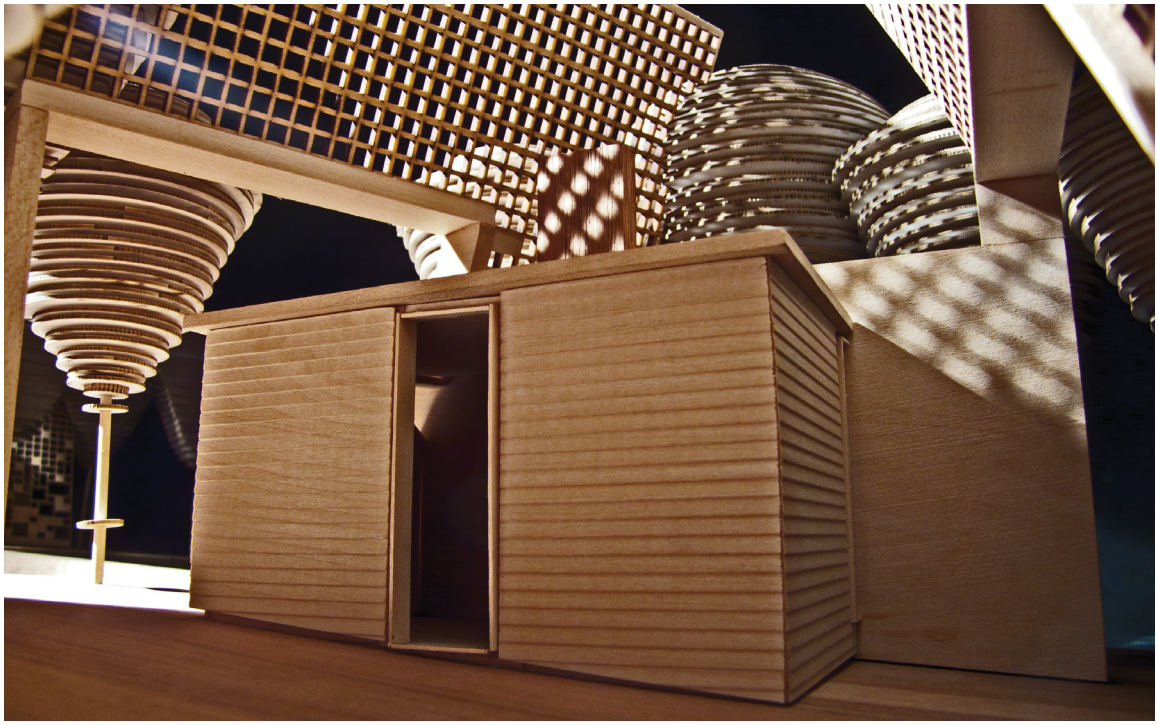
Proportions

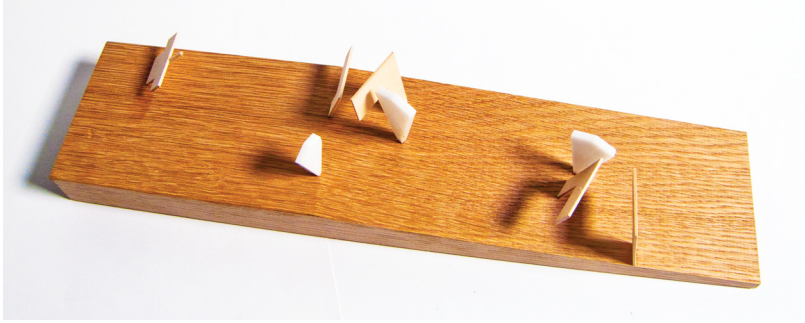
The relationship between structure and forest is a significant one when considering the light quality at the forest floor. This issue is dealt with using a series of screen/wall elements, that interact with the canopy zone discussed previously. These elements have several functions. The first and most important, is to manipulate the canopy zone to allow light to penetrate the forest floor, the second deals with views. These are formed from a structure that takes into account the proportions of the trees and framed views below the canopy zone. These frames and views are also the same formal elements which are experienced as thresholds while moving through the space. Linking these elements into one assembly, is significant in minimizing the impact on the land.



Above: Drawing showing the relative proportions of a white birch (p.33)

Below: Image of the screen being supported by the frame



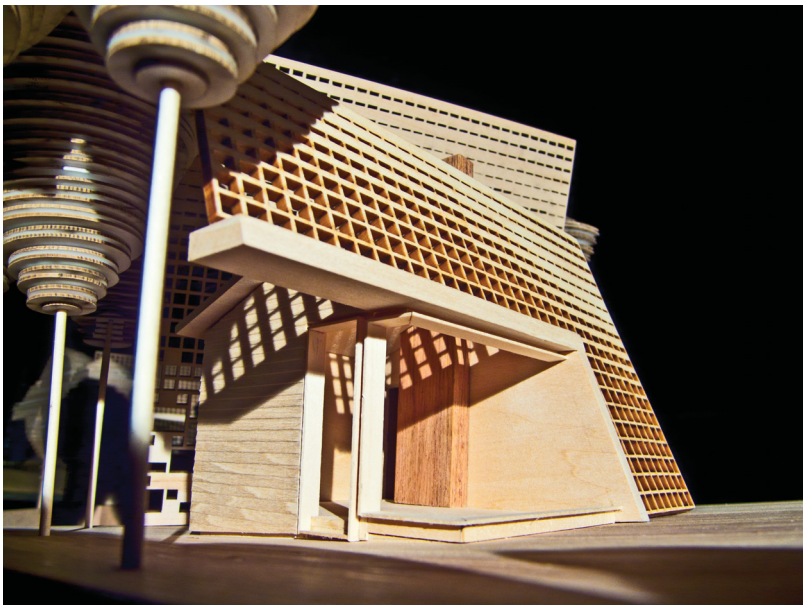


Left: Image of a small model showing the proportioning system on the site

Harvesting

The sun provides for us both light and energy. These two things, which come from one source, are experienced by humans in two distinct methods: thermal, and visual sensation. These two factors each need formal resolution, which allows one to properly experience to the fullest. The visual experience comes naturally through dappling that is created from the forest, and artificially, from the concrete screens that project themselves upward to pull the light down.

The thermal experience is achieved in two ways. The first, through direct sunlight in the living space of the cabin with absorptive flooring materials, and also through a trombe wall which blocks out direct light in the sleeping space. This trombe



Model 1/4”=1’-0”
Showing the light entering through the south facade deflecting through the screen

wall is necessary for retaining heat throughout the day and utilizing it in the evening, when direct light is not available. These two means of harvesting the sun are experiential qualities the user will encounter throughout the day and may or may not even realize the interaction.

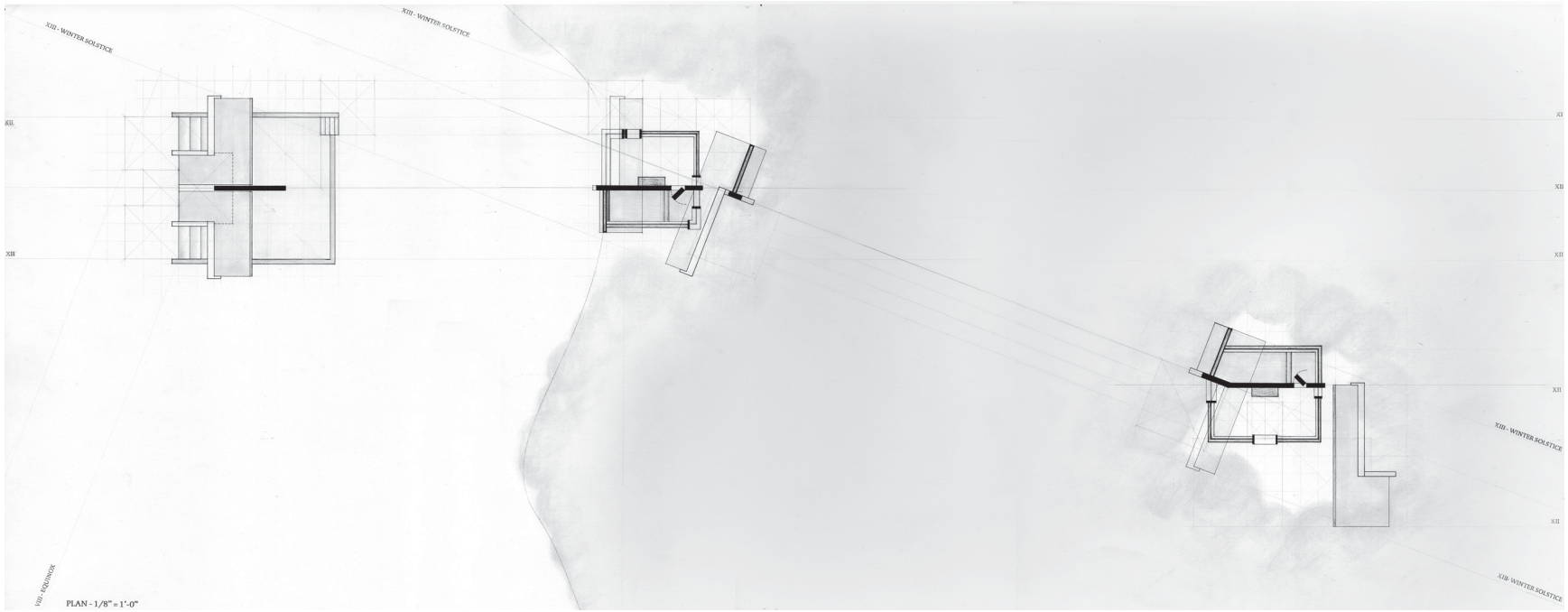
ARCHITECTURE

The combination of intensive research, a site, program, and client, have resulted in a design project which has several means of representation. The following documentation of this work should be considered as a whole, while keeping in mind the research conducted throughout the previous chapters.

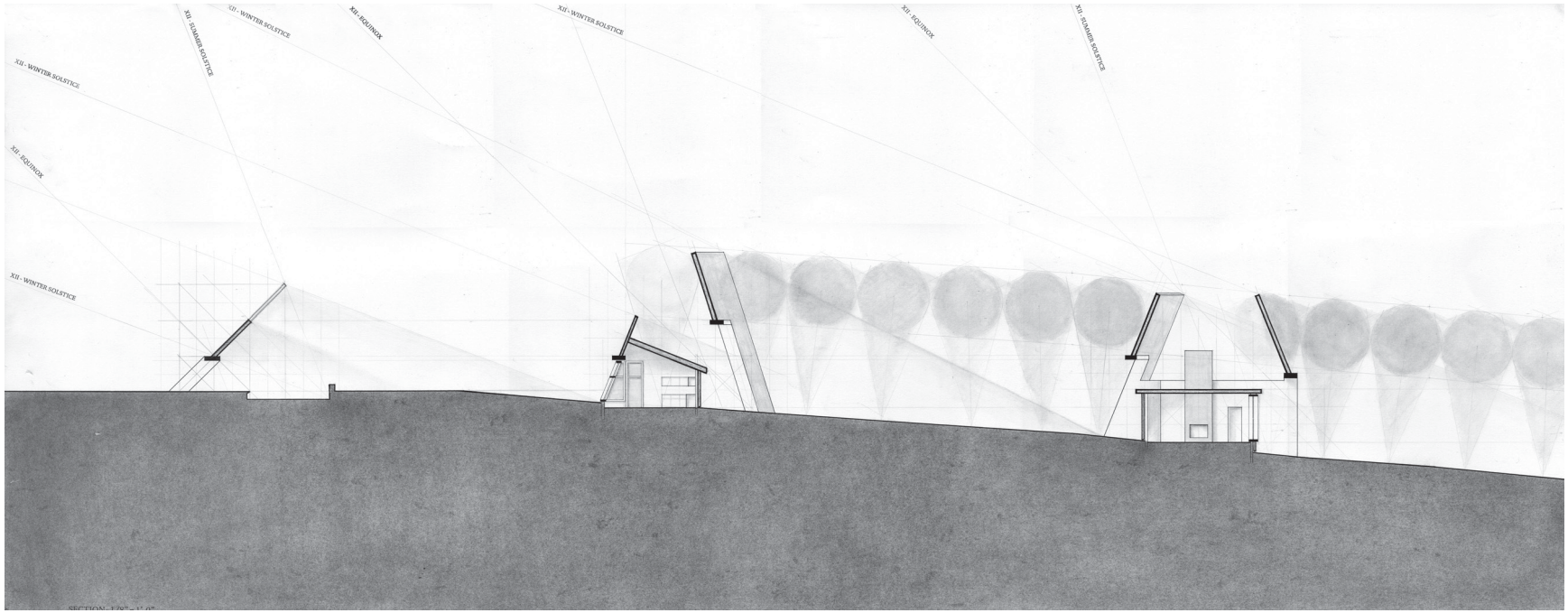
Drawings

The main relationship between all three structures can be seen in the following drawings. A plan and section of the whole shows overall relation, while the blown up plans and sections show internal relationships within each individual structure. Finally, the detailed section of the living space shows the relationship between the screen and trombe wall. This detail allows for the surface to capture heat throughout the day, saving heat for the night when the artist returns to sleep.

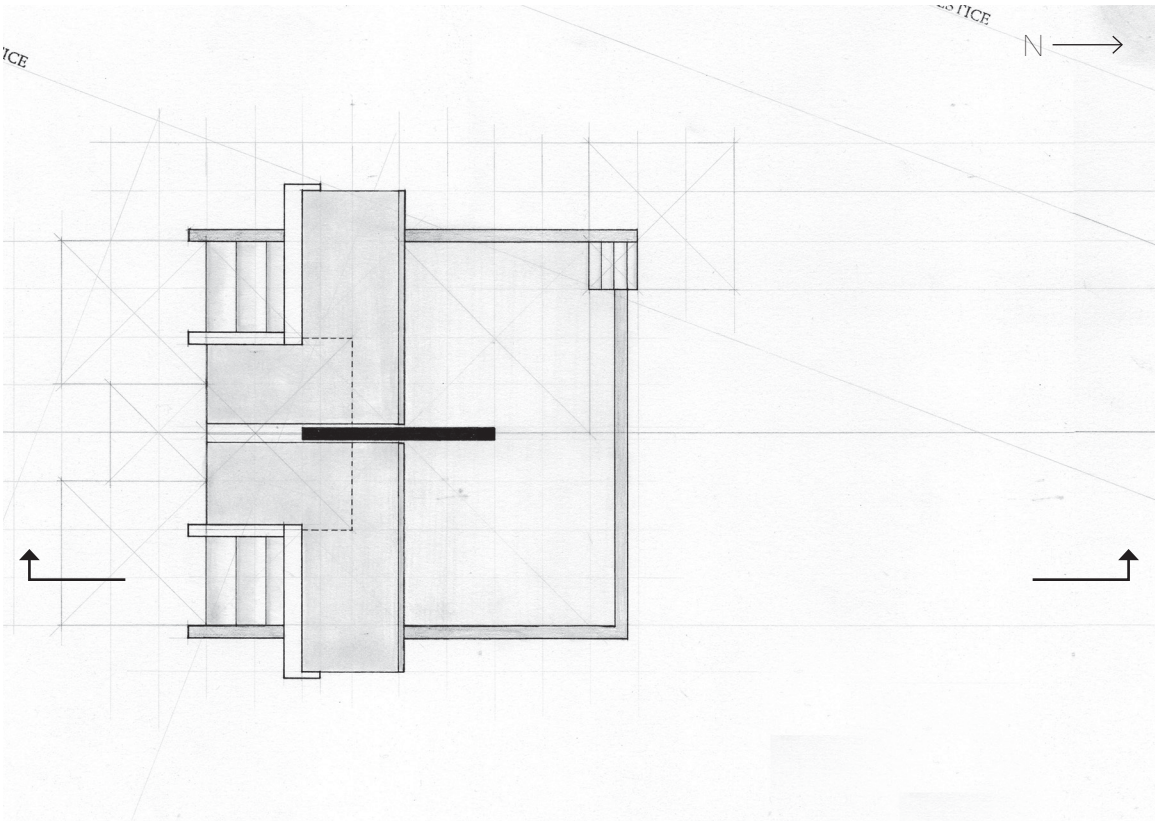
The final page shows an image of the whole. This is a collage of images representing the relationship between each structure. The change in elevation can be seen by the depth of shadow cast by each section of the model.



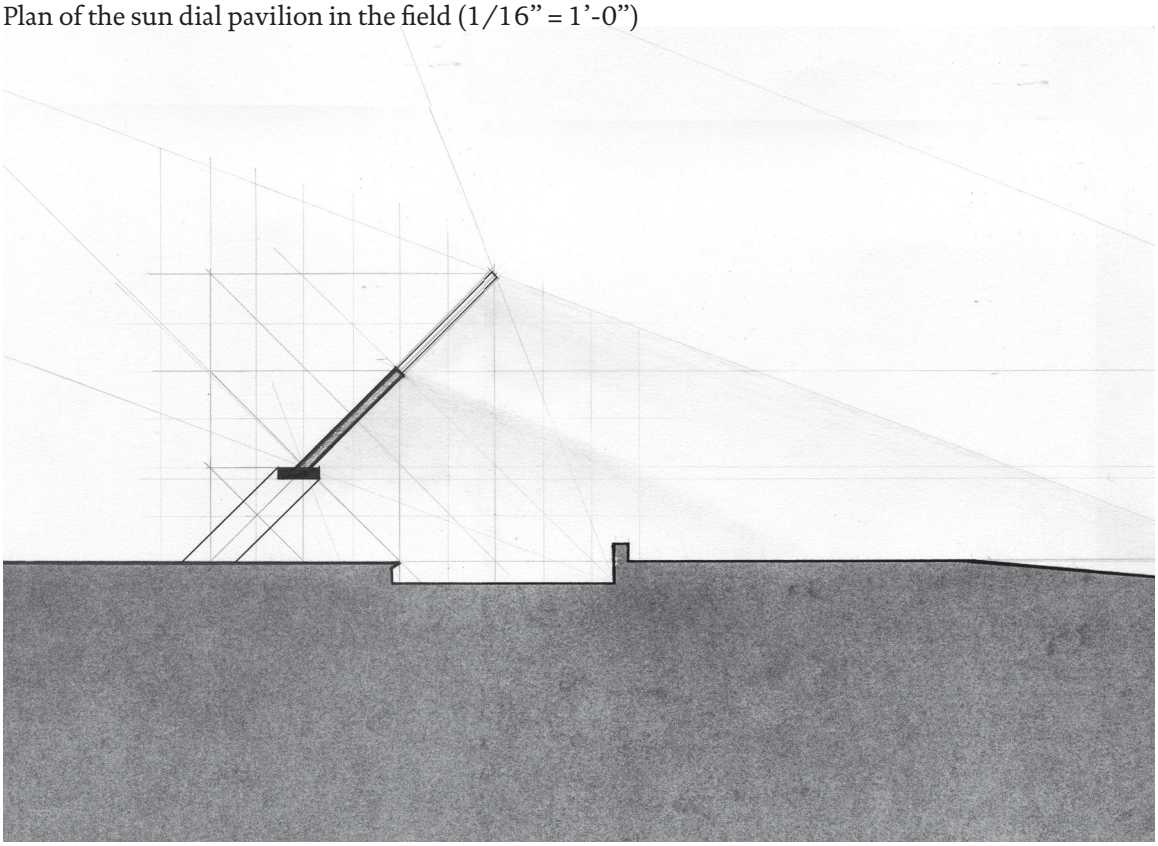
Plan drawing of the three buildings



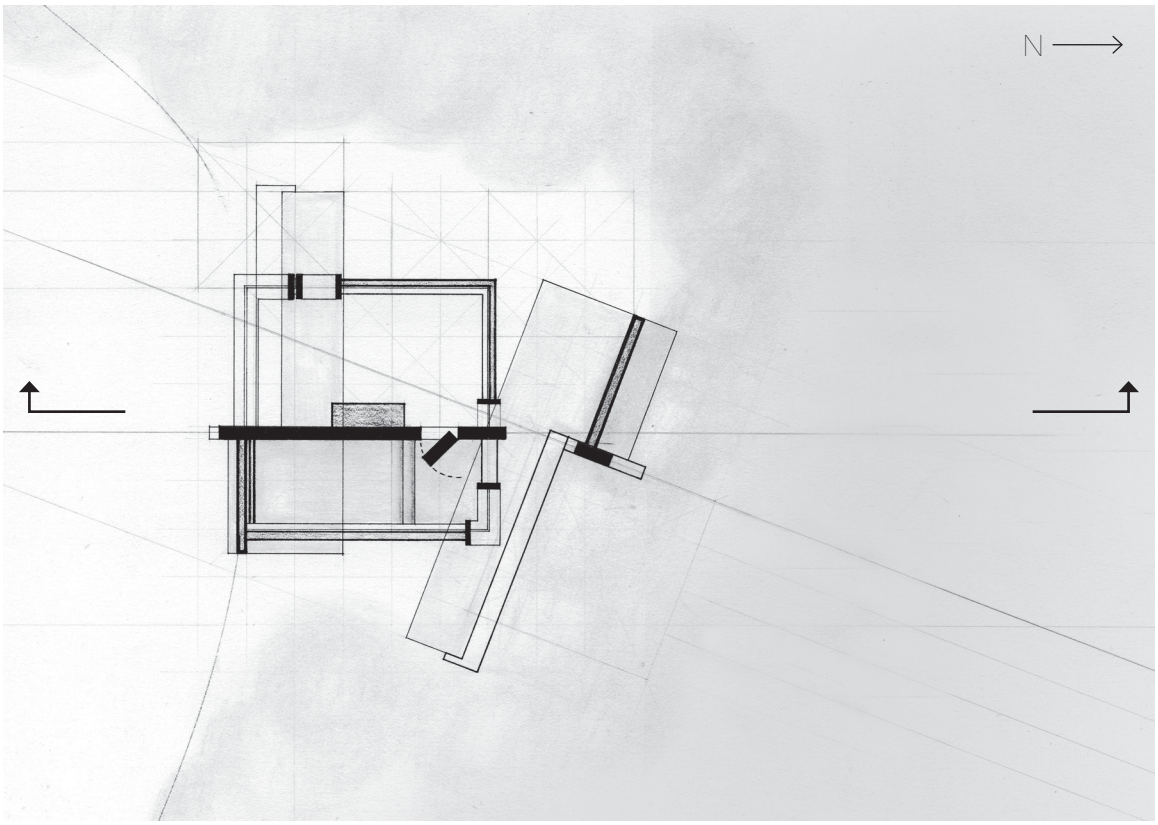
Section drawing of the three buildings



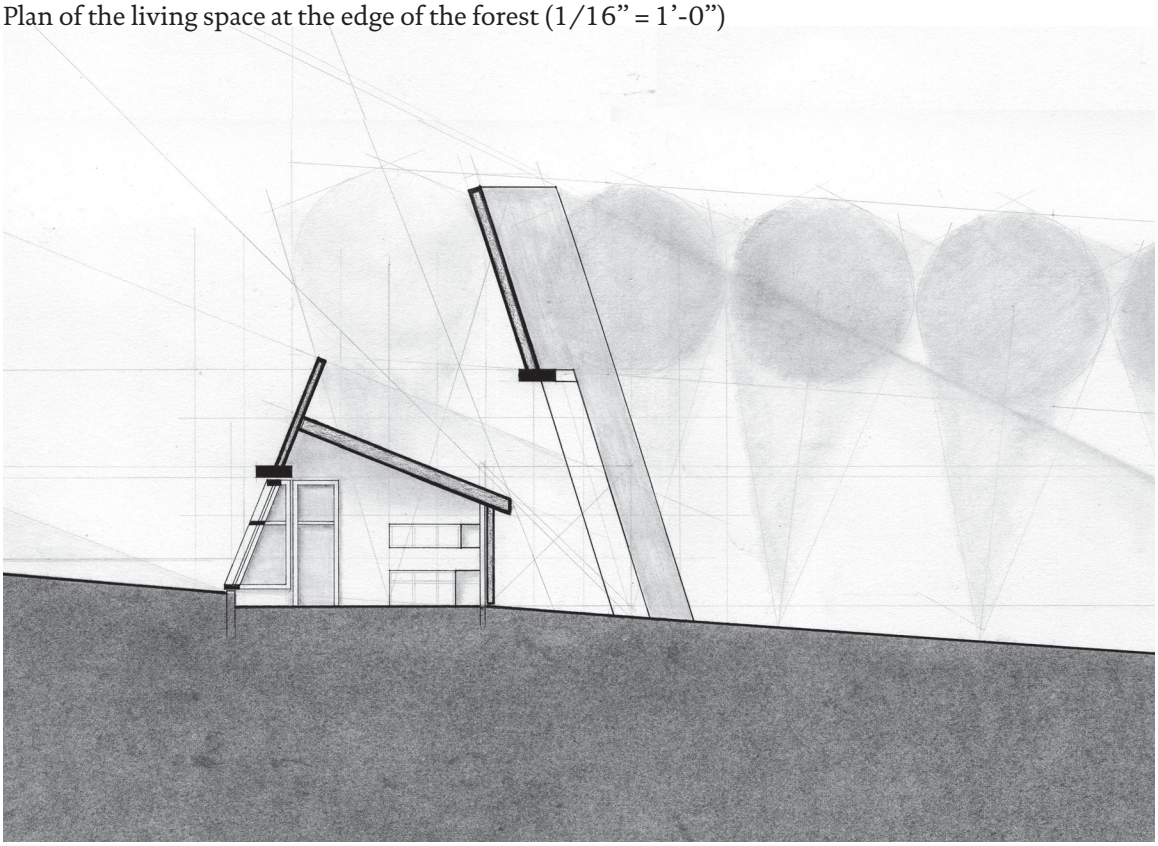
Plan of the sun dial pavilion in the field (1/16” = 1’-0”)



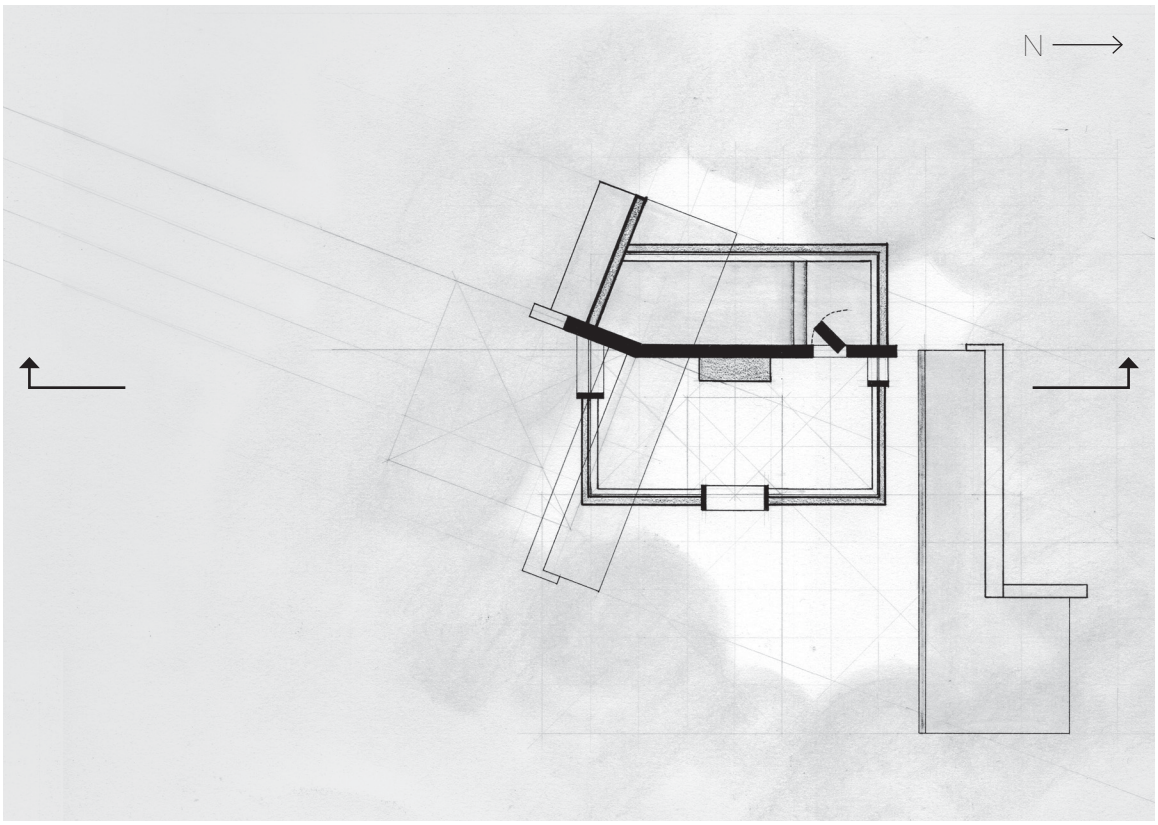
Section of the sun dial pavilion in the field (1/16” = 1’-0”)



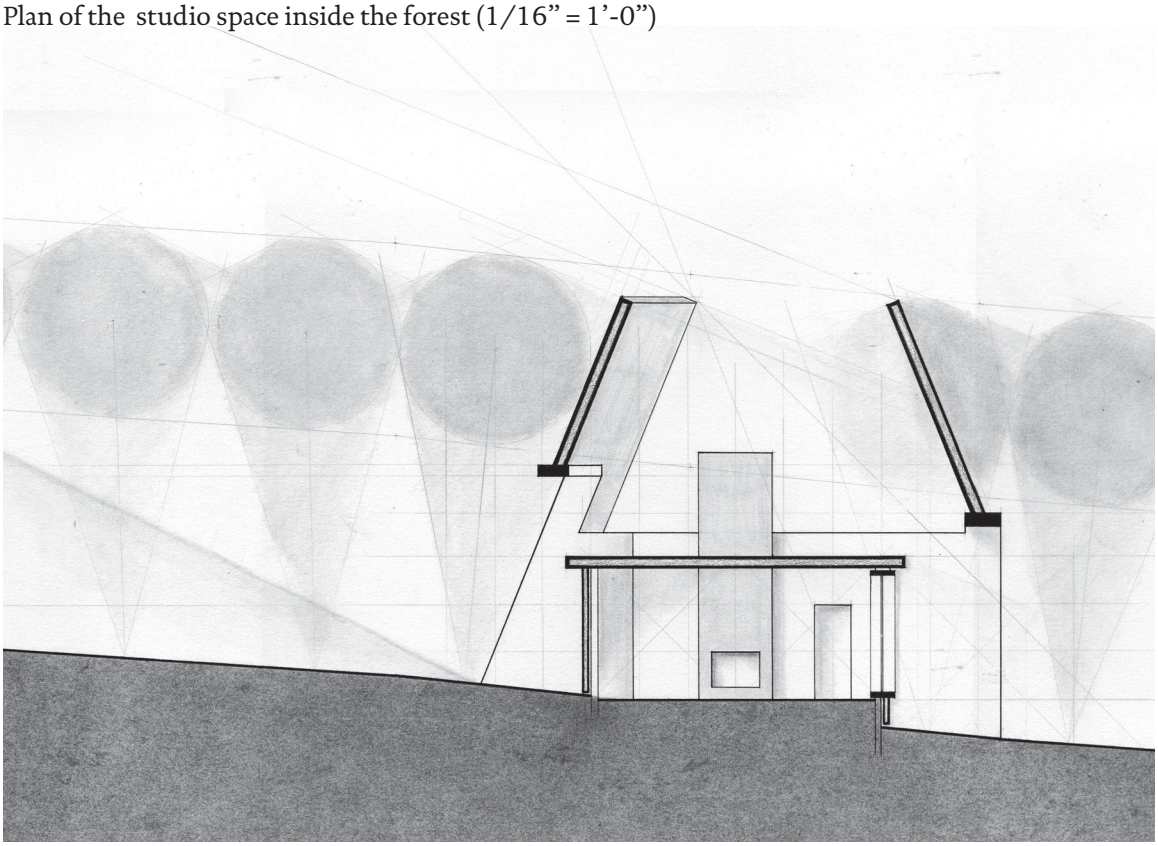
Plan of the living space at the edge of the forest (1/16” = 1’-0”)



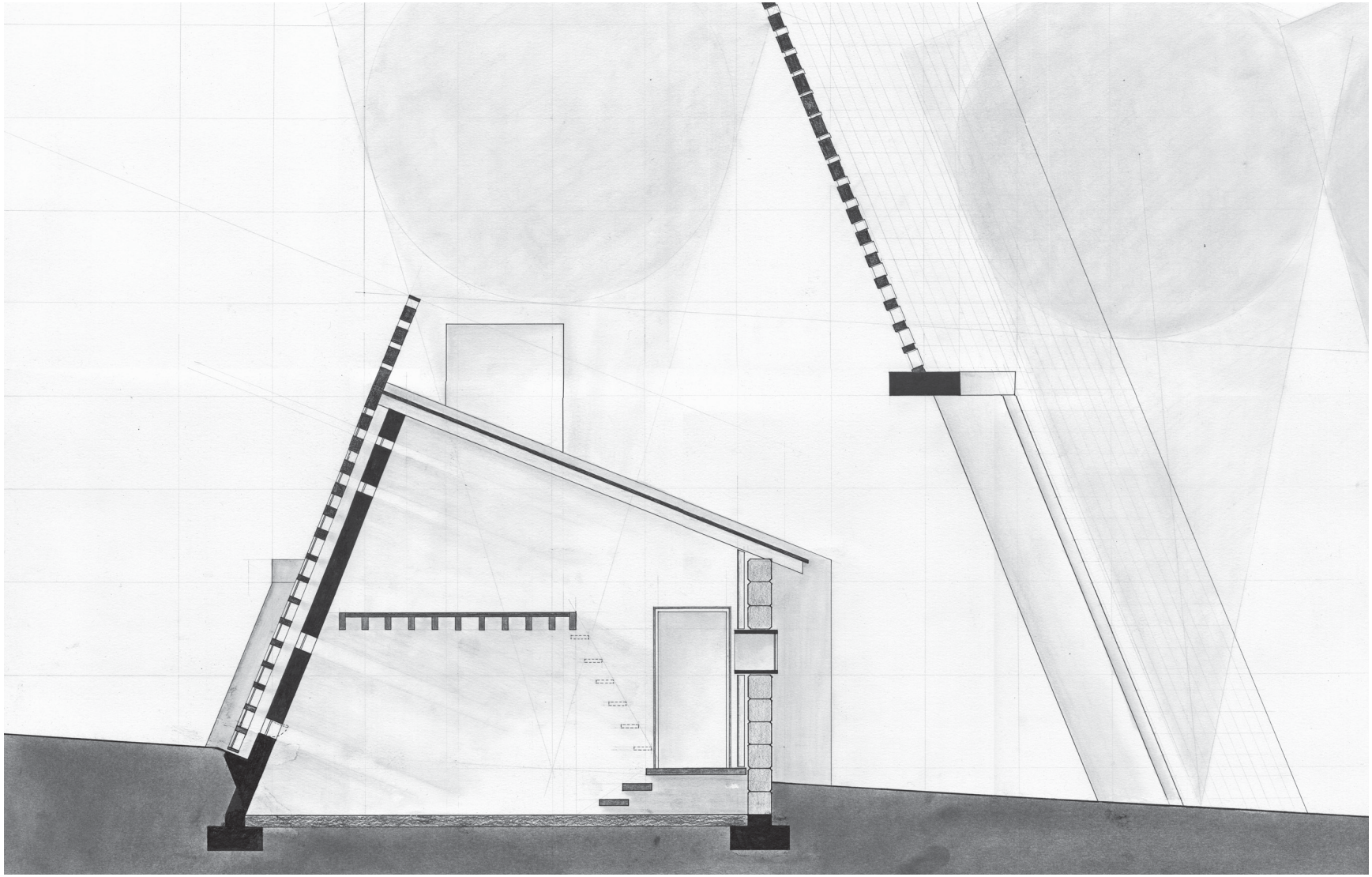
Section of the living space at the edge of the forest (1/16” = 1’-0”)



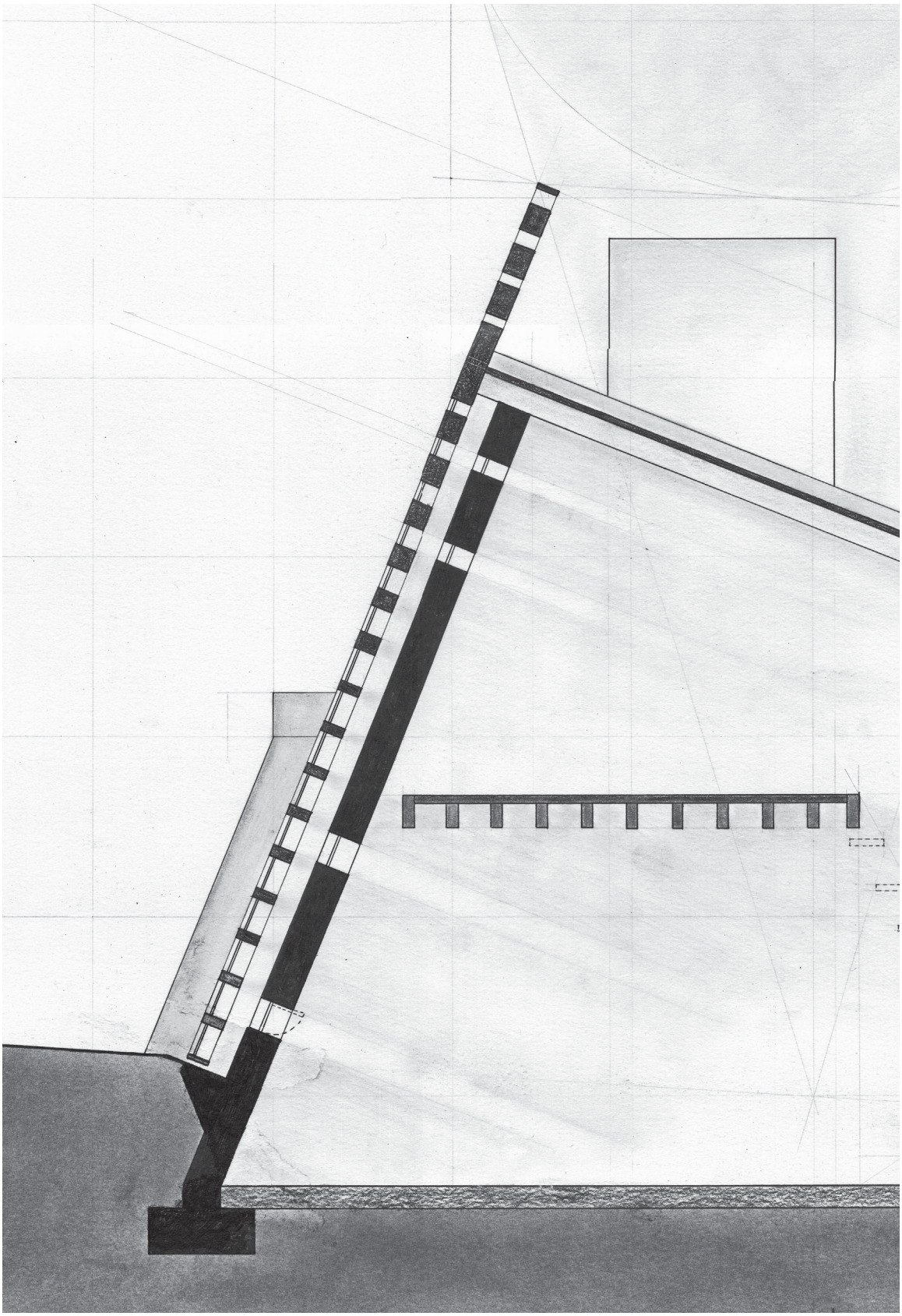
Plan of the studio space inside the forest (1/16” = 1’-0”)



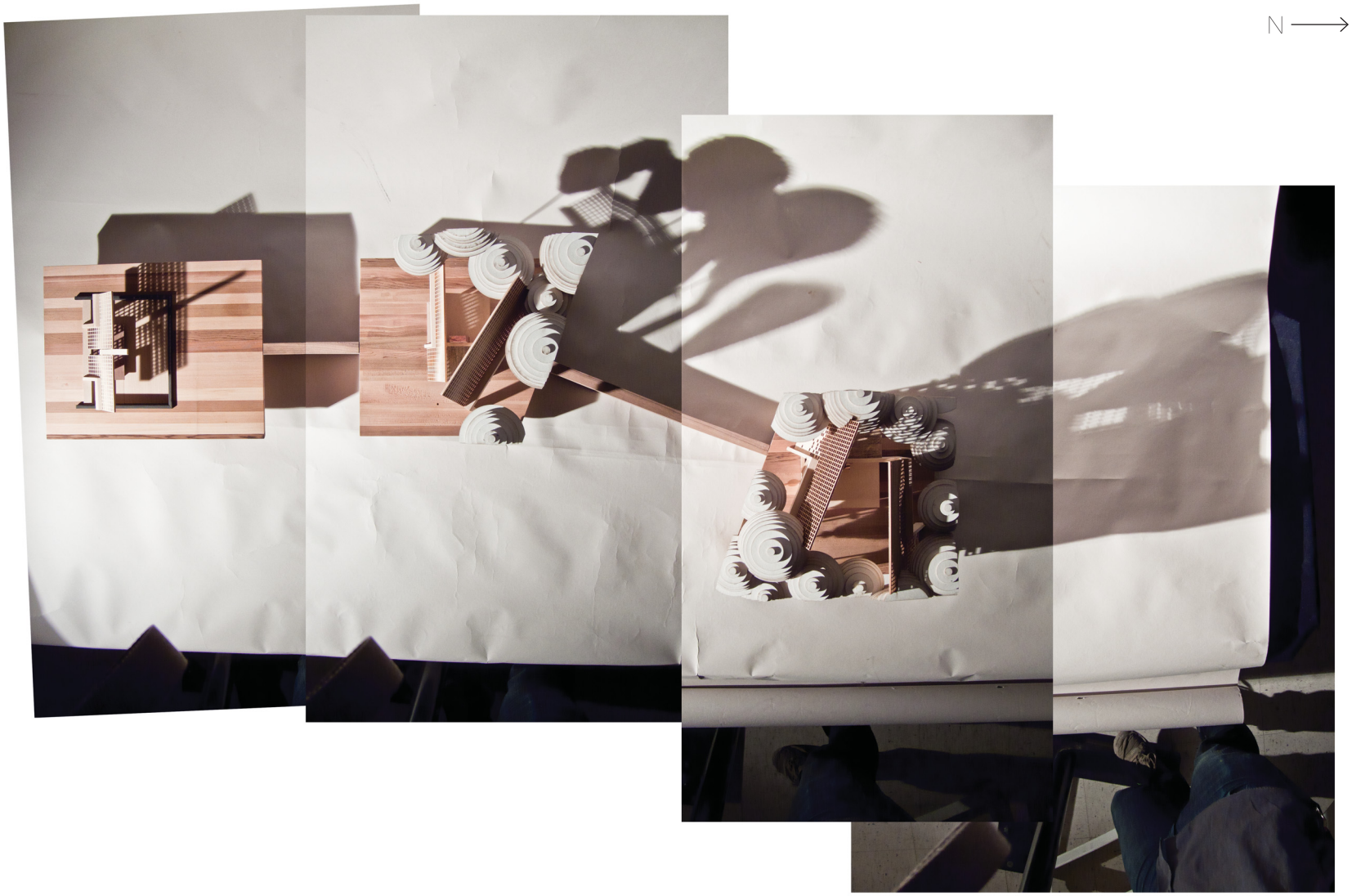
Section of the studio space inside the forest (1/16” = 1’-0”)



Detailed section drawing of the sleeping area of the living structure



Detailed section drawing of the trombe wall and small openings



Collage showing the model in plan (1/4” = 1’-0”)

Photographs

The second series, a collection of photographs illustrates the procession and visual connections from structure to structure as you move from the field to the forest. These Images also describe the light qualities and penetration from the direct sun on both the screens and structures from various times of the year.

These relationships are those which create the experience through a series of structures that allows one to navigate their way via celestial clues which are cast down onto various surfaces.

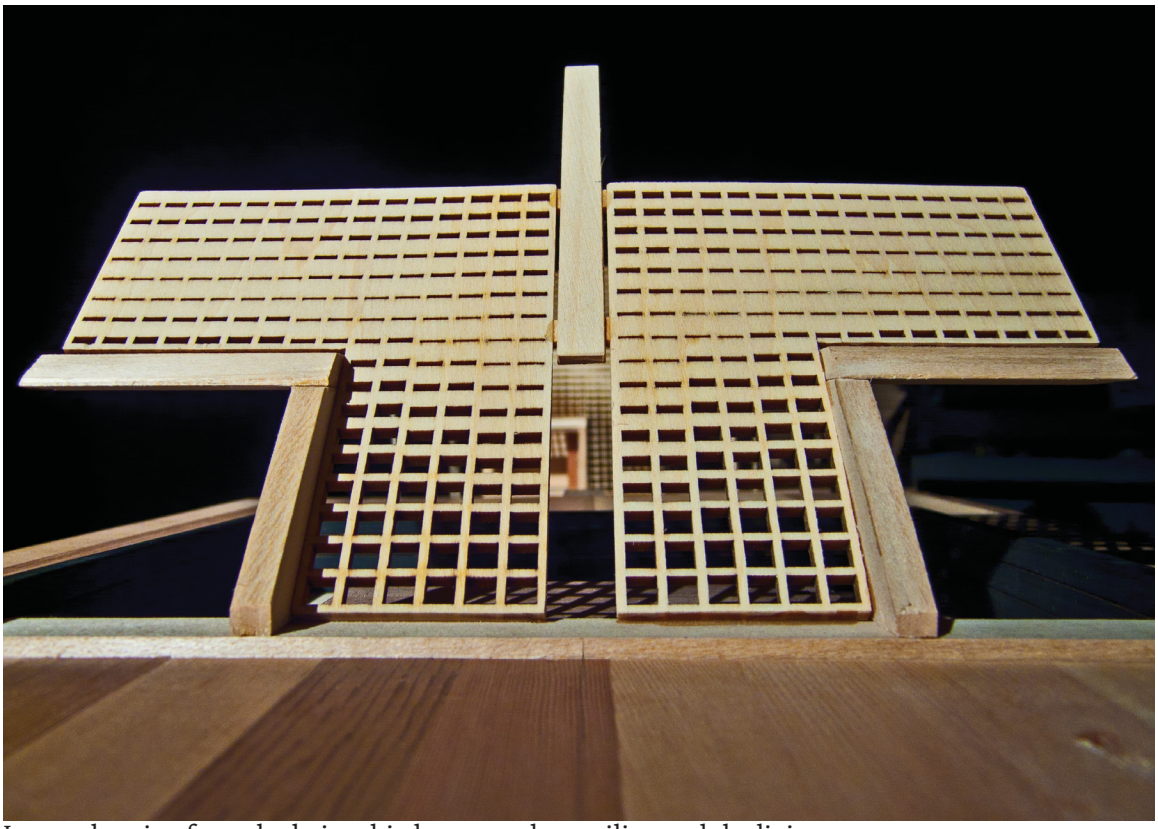


Image showing formal relationship between the pavilion and the living quarters

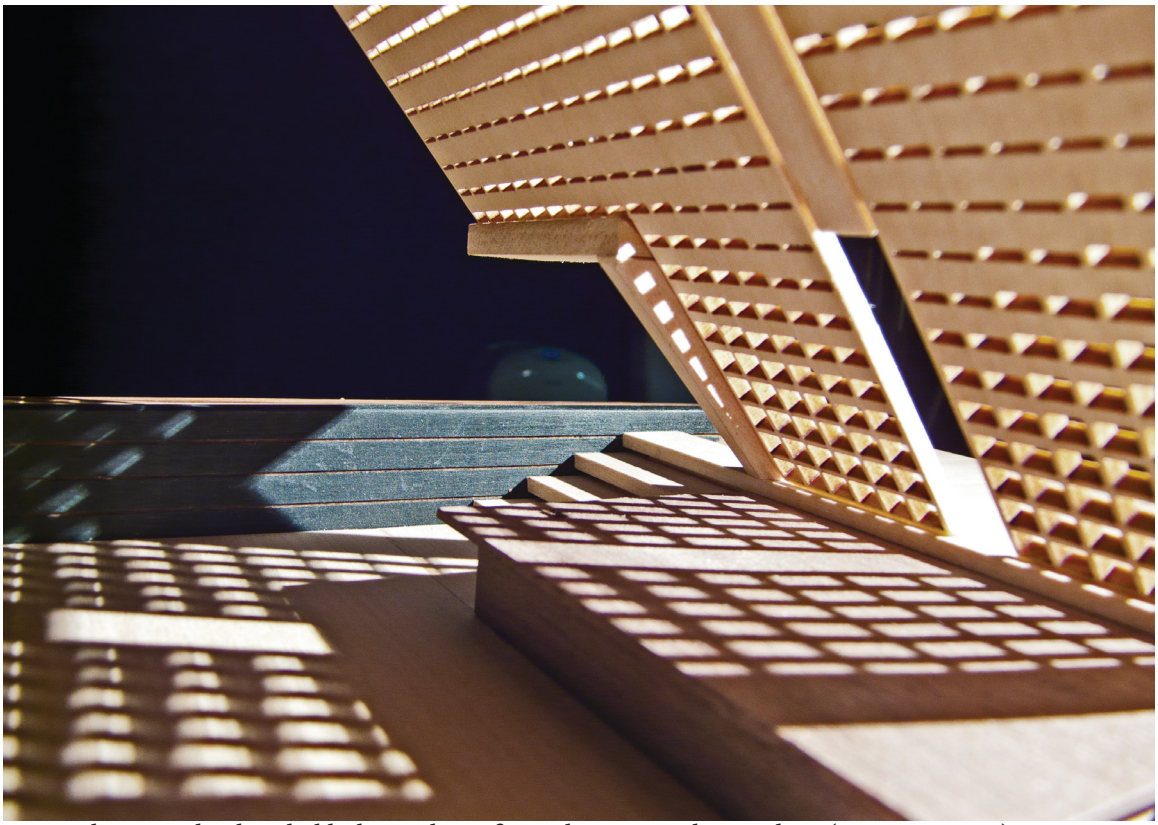


Image showing the dappled light qualities from the sun on the pavilion (13:00 Oct. 17)

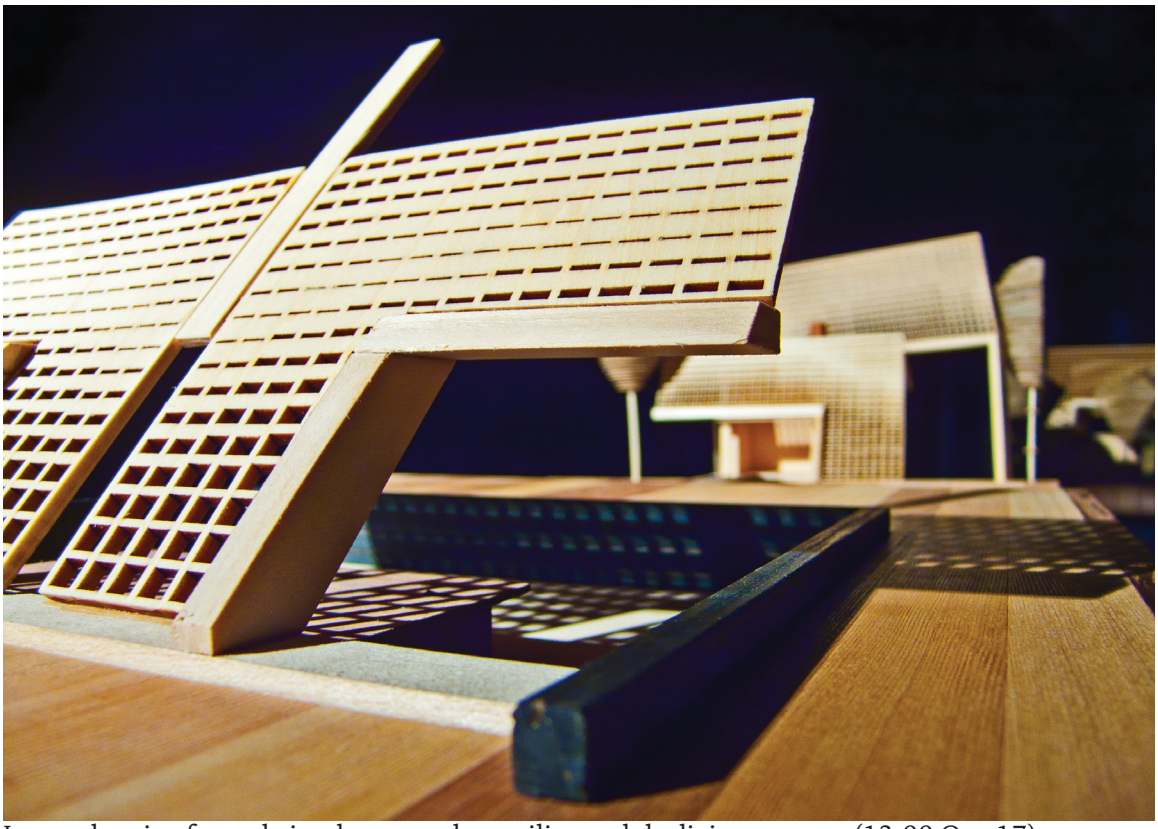


Image showing framed view between the pavilion and the living quarters (13:00 Oct. 17)

Image showing the view of the pavilion from the living quarters (14:00 June 10)

Image showing the light penetration on the living space through the large south window

Image showing the dappled light qualities from the sun on the building (14:00 June 10)

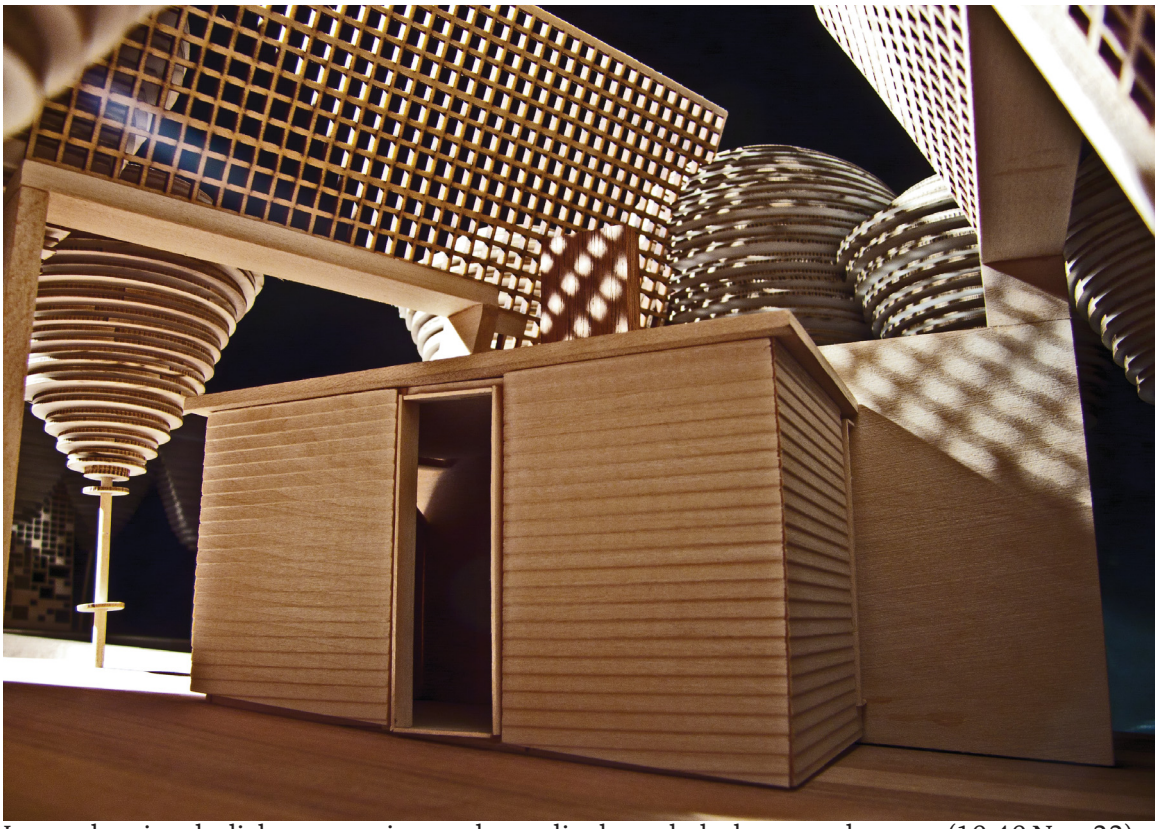


Image showing the light penetration on the studio through the large south screen (10:40 Nov. 22)

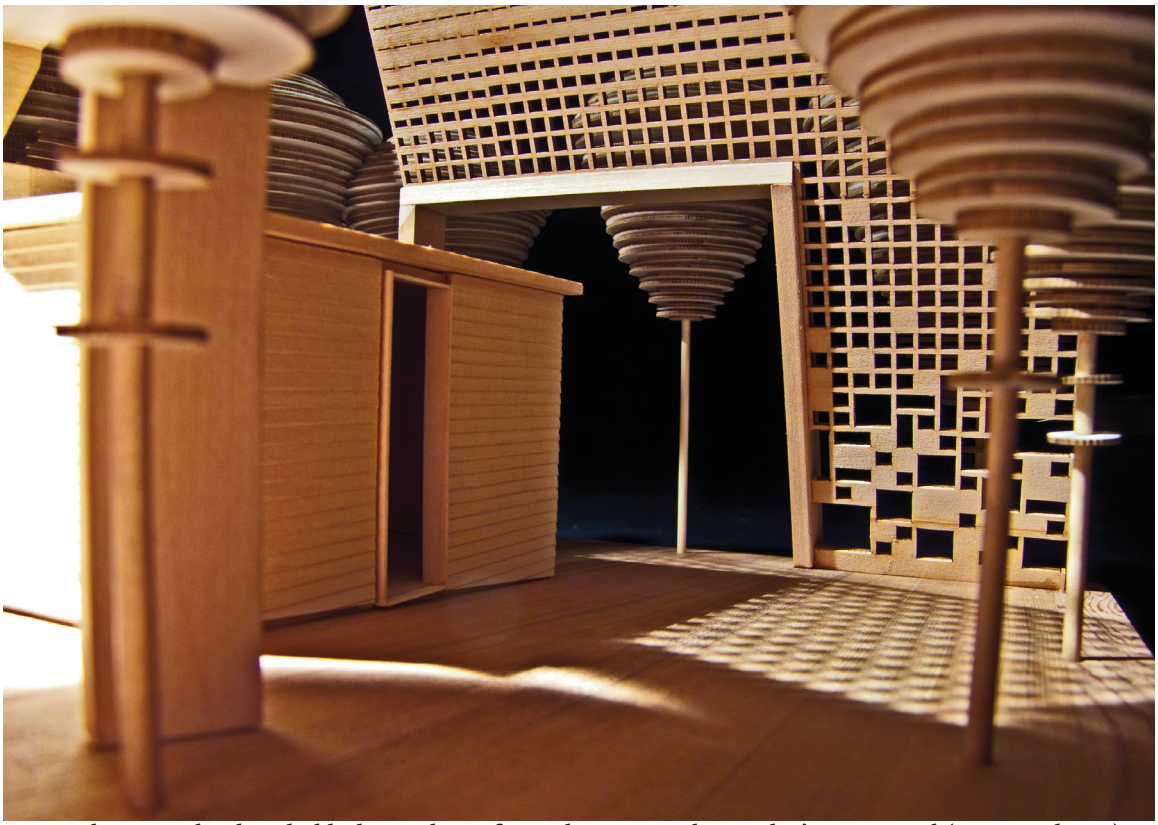


Image showing the dappled light qualities from the sun on the studio's courtyard (14:00 July 04)

Shadows

The relationship of shadows to the time of year is one that is inseparable. The following images display this relationship. You'll notice on the following page that the proportion of day-light hours in the summer vs. the winter is proportional to the amount of space used on the page by each season. This is due to the fact that each image is taken at increments of 15º as the shadows move horizontally. The time shown below is the is the relative solar time associated with this movement. The image directly bellow displays the variation in shadow from season to season at 12:00.

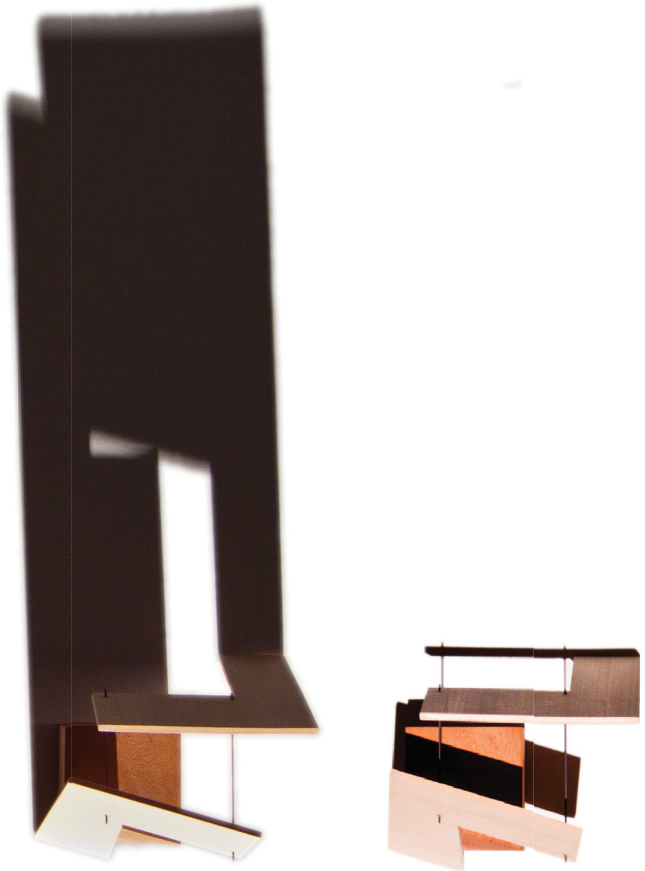


Image showing the difference in shadow between seasons (12:00)

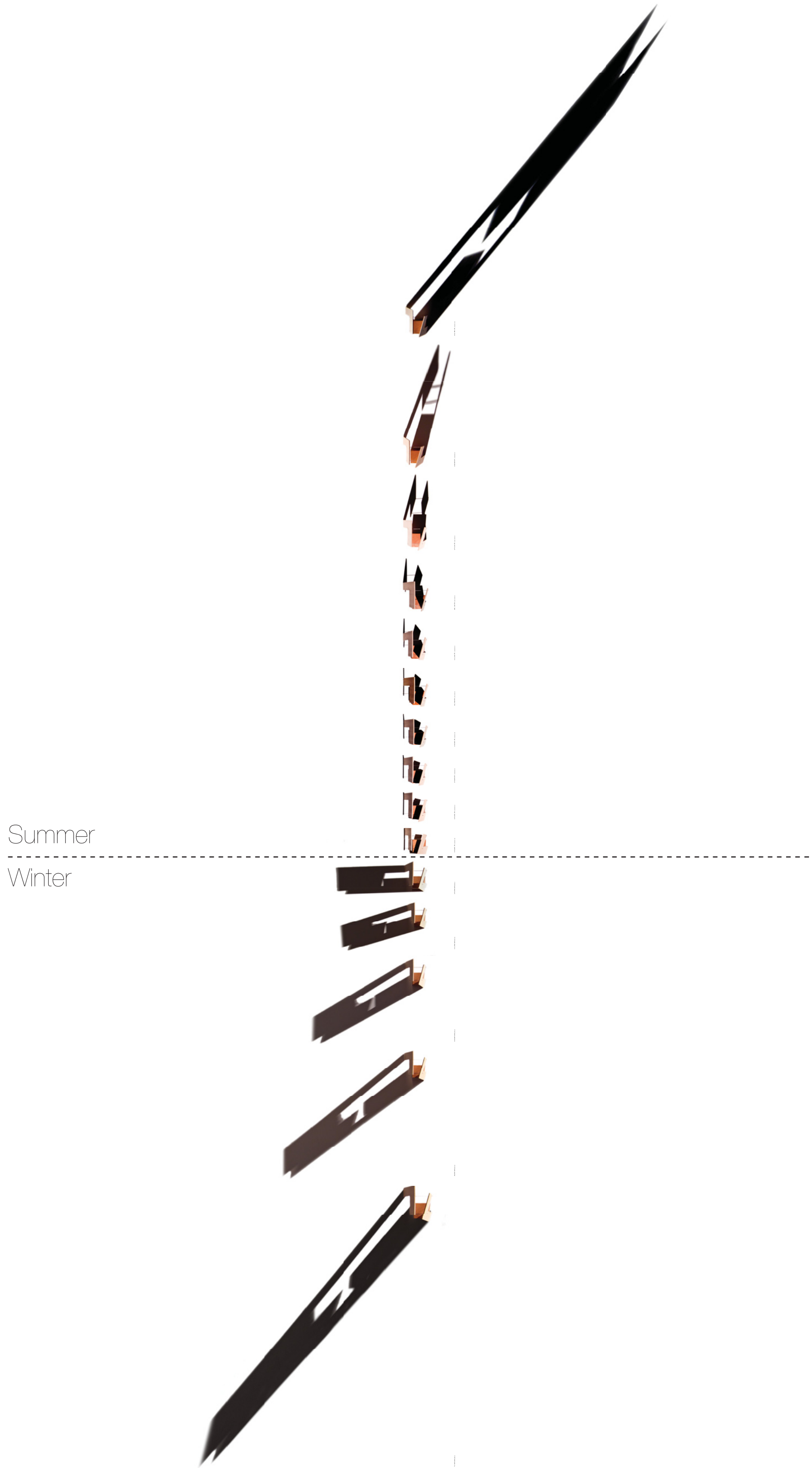


Image showing the variation of shadows from winter to summer

Image showing the morning shadows through the winter

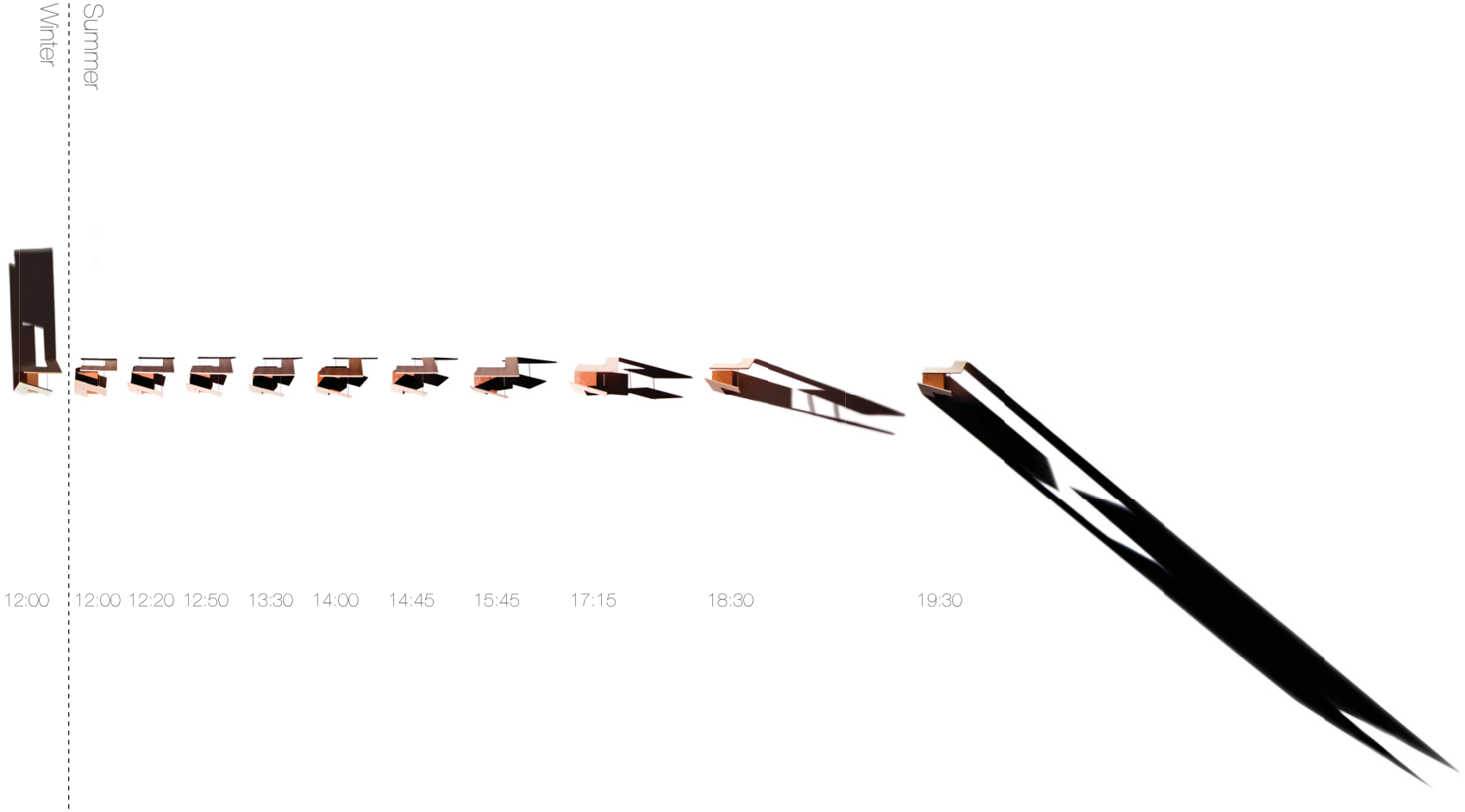


Image showing the afternoon shadows through the summer

CONCLUSION

A body of work such as this one, requires acknowledgement for what can be taken from it as much as or more than that which it constructed. The design executed here, is an exploration of the possibilities which result from the research and tools explored through the early chapters.

The sun is a very strong and important element in architectural design. It acts as a clock, a calendar, and a source of energy. It provides form for all settlements around the world. Understanding the patterns of the sun is that which will allow architects to create, in a manner specific to a place. The movement of the sun needs to be studied and understood at a level which allows one to carefully determine its location, magnitude, and thermal value. These details, which we have lost knowledge of in recent years, are the very reason for the inefficient architecture created around the world today.

The artist retreat has been an exploration in resolving the issues brought up uring the research and history, but more importantly it has been a place to experiment with methods of enhancing the human experience, through the warmth and dynamic movement of the sun. The play of light created by the textured screens, has allowed the light to flow in a manner not entirely unlike that of the diffused light produced by the trees. One difference which can be found is the rigid nature of the screen vs. the dynamic one which the trees produce.

Further, the materials used in construction are ones which reflect the program and interior climate needs of the user. Both spaces intended for controlled lighting and temperature, have robust charred timber log walls to mediate temperature fluctuation throughout the days and seasons, much like that of the forest from one season to the next.

These material dfferences allow for each individual piece of architecture to have meaning and place in the landscape. These subtle differences make the user feel like the space has been crafted for the task at hand, whether it be sleeping, eating or processing film. Not only are the interior spaces shaped and tuned for programmatic use, but so are the exterior spaces around each built form. Allowing one to inhabit the space around a building, makeing each structure feel larger than it is. This minimizes in the excess use of materials and energy and in turn allows individual deviation in artistic occupation.

Architecture has grown from the basic need for survival; which in our climate are based on protection from the cold. If we can achieve a passive, first principles architecture to shelter out the cold and harvest in the sun we can drastically reduce our impact on the land. In turn we will be far more in tune with the natural cycles the earth produces daily and yearly. In recent times these methods have been undervalued, but if we want to achieve a sustainable future paying great attention to embedded knowledge of natural and traditional inhabitations (that which worked for so long) will be of paramount concern.

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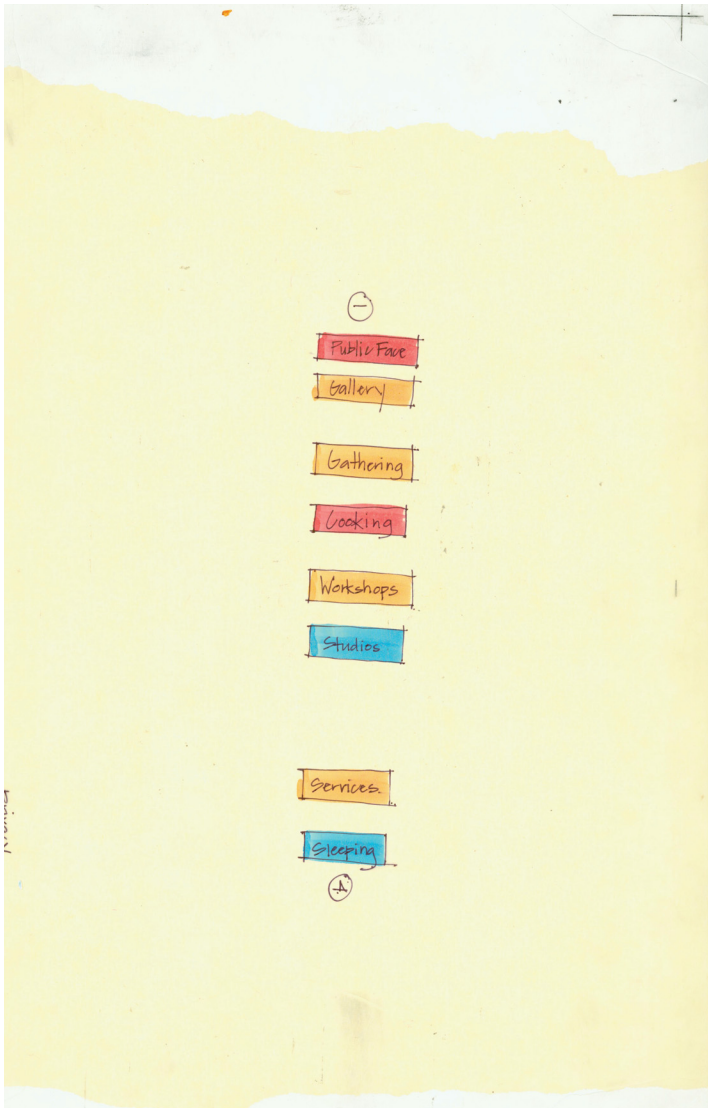
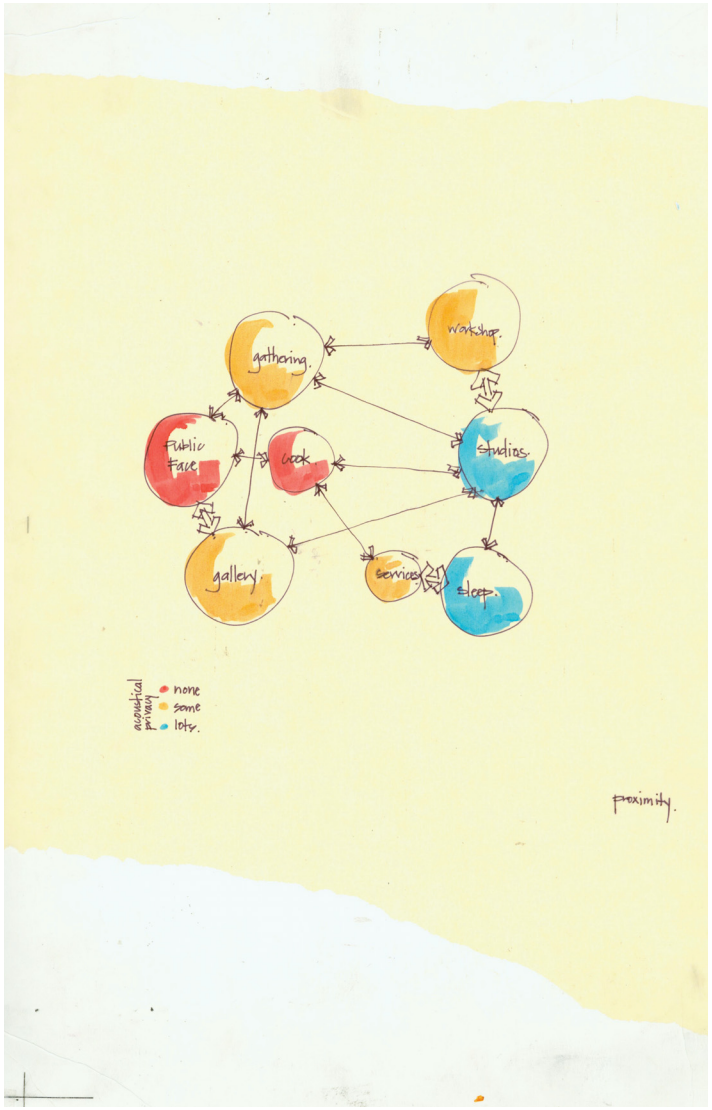
APPENDICES

Appendix A: Artist Retreat Master Planning Exercise

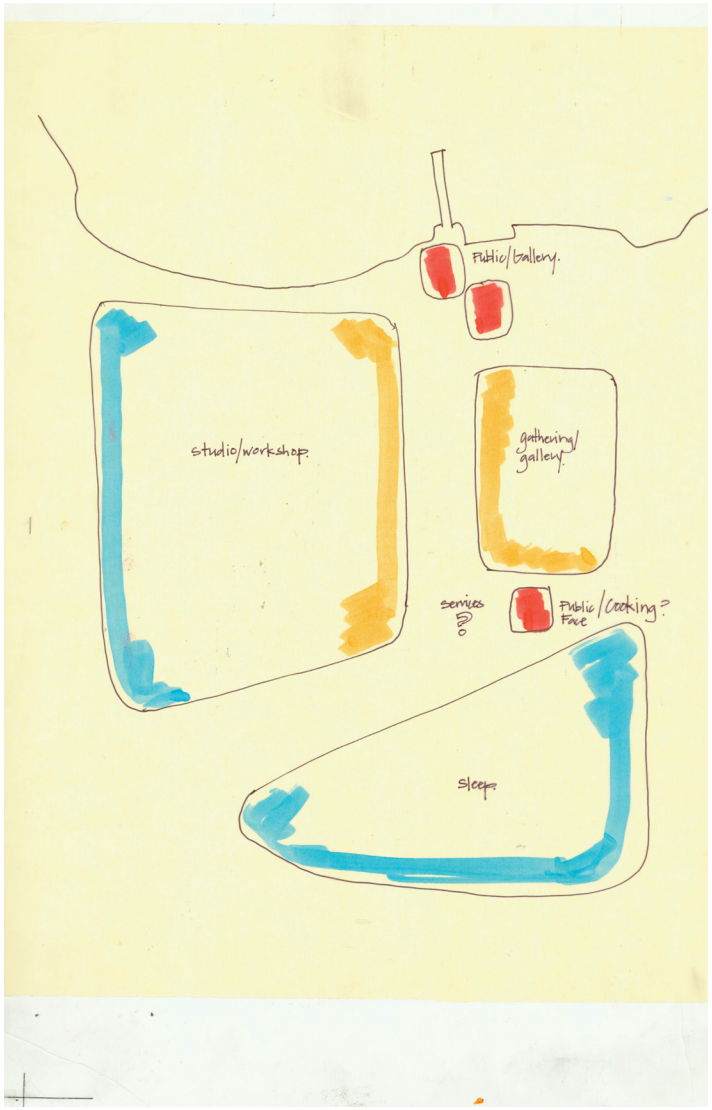
This study took place in the summer of 2009 During a Graduate studio, located on the same site, dealing with the large scale workings of an artist retreat. The following collection of diagrams explains the process which was used for determining the sitting of the various program elements. Project team: Mark Aseltine, Rebecca MacKenzie, Amber Pesklevis(Drawings by Rebecca MacKenzie)



Program analysis: categorized by noise level

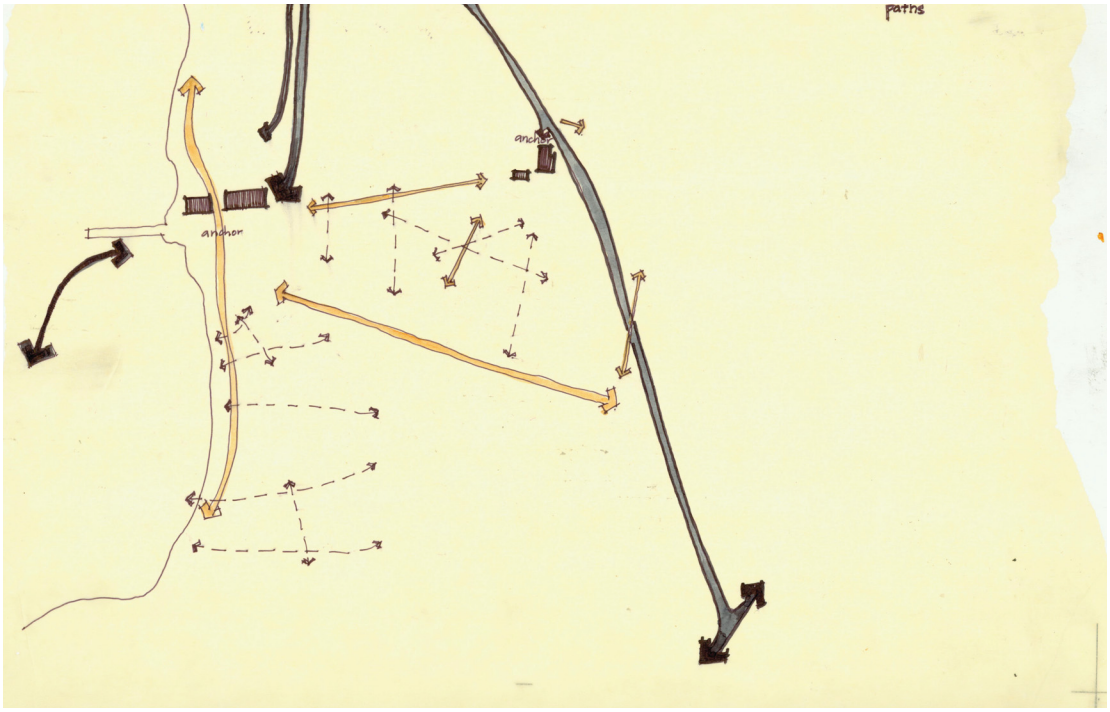


Program analysis: organized based based on necessary proximity and noise



Program analysis: located on site with relation to noise level emitted

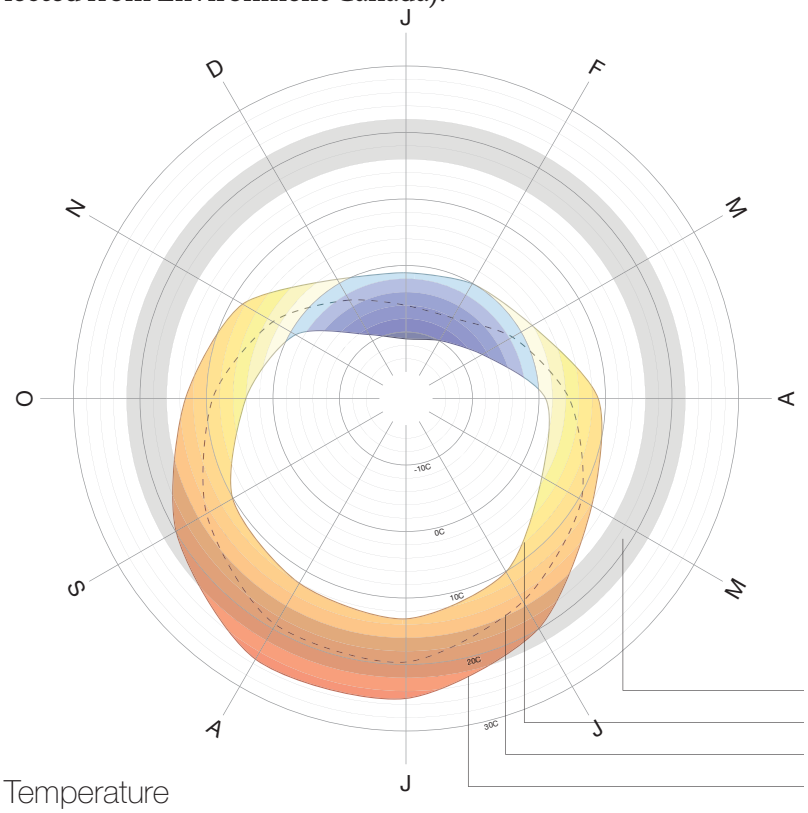
Site analysis: Major views and key stopping points



Site analysis: major paths and thoroughfares

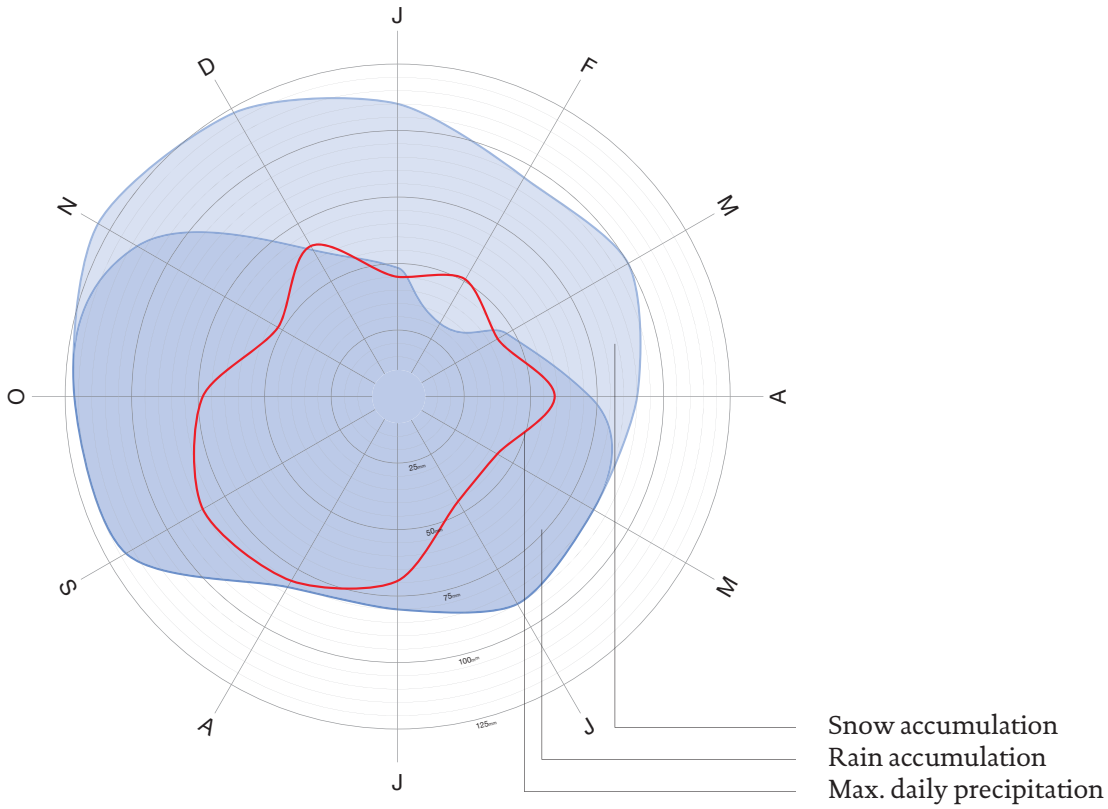
Appendix B: Climate Data For Caribou, Nova Scotia

The following Appendix includes a collection of climate data collected during a graduate elective in my thesis preparation term. This data includes average statistics for temperature, wind, precipitation, visibility and colour cover. (All data collected from Environment Canada).



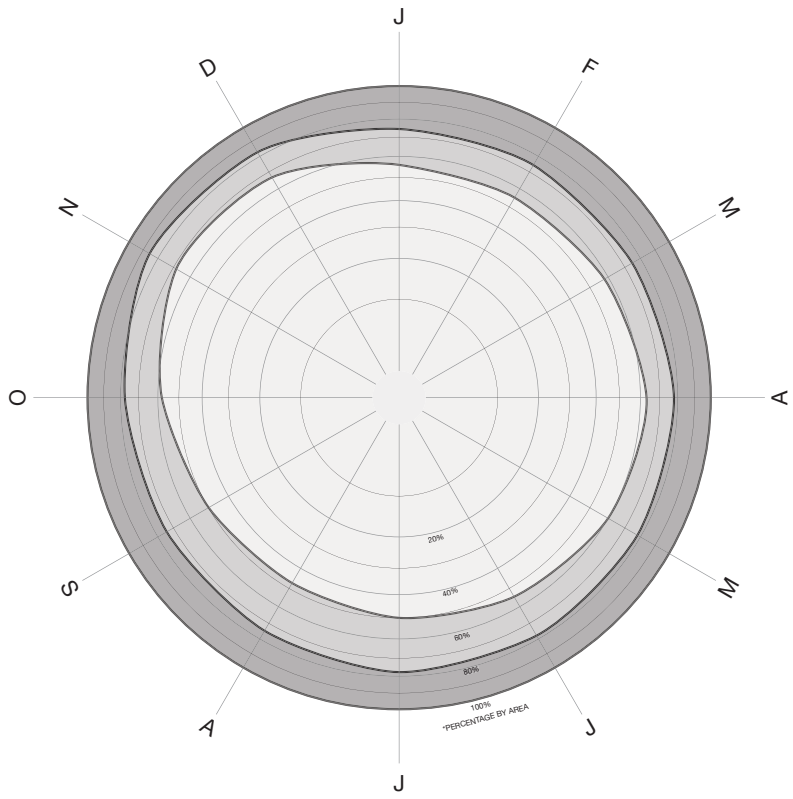
Temperature

This temperature data, although useful may be deceiving in its content. Halifax has a very diverse climatic system, one which requires to be looked at from many facets. Some of the most telling climatic data is that which can be found through site analysis, not only that which falls within the site boundaries but also that which can be seen within the local surroundings. What we can see though this set of data tells us that the range of temperature which must be considered when building is extreme. Ranging from an average daily high of 24.7 in July to an average overnight low in January at -11.1 degrees Celsius. This is a range of 35.8C throughout a calendar year.

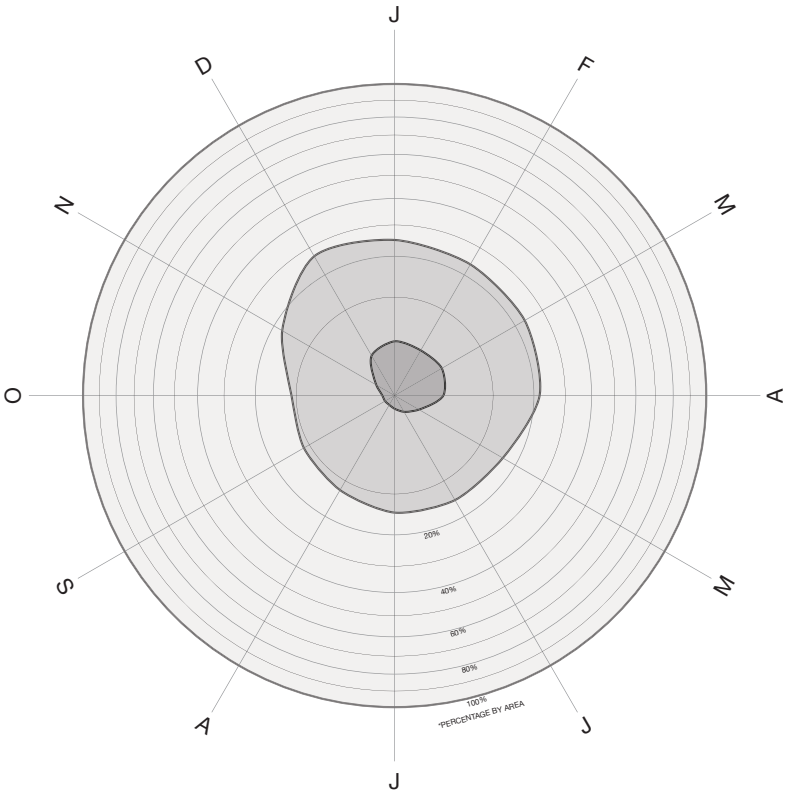


Precipitation

Precipitation data in this region is extremely useful in the way one works through a design phase of any architectural endeavor. In Nova Scotia there are two facts which are key in the success of water management on site and on envelope penetration. The first is that which sees a daily maximum of rain during the months of August to October over 75mm. This amount of rain can cause extreme drainage problems in and around a building. The second lay in the winter months between January and March when over 40cm of snow can fall in one day and up to 75mm during each of those months. These two scenarios will require to be addressed seamlessly due to the nature of this site being exposed to the Northumberland straight and the program which will require an abundance of exterior circulation.



0 - 20%
21 - 70%
71 - 100%



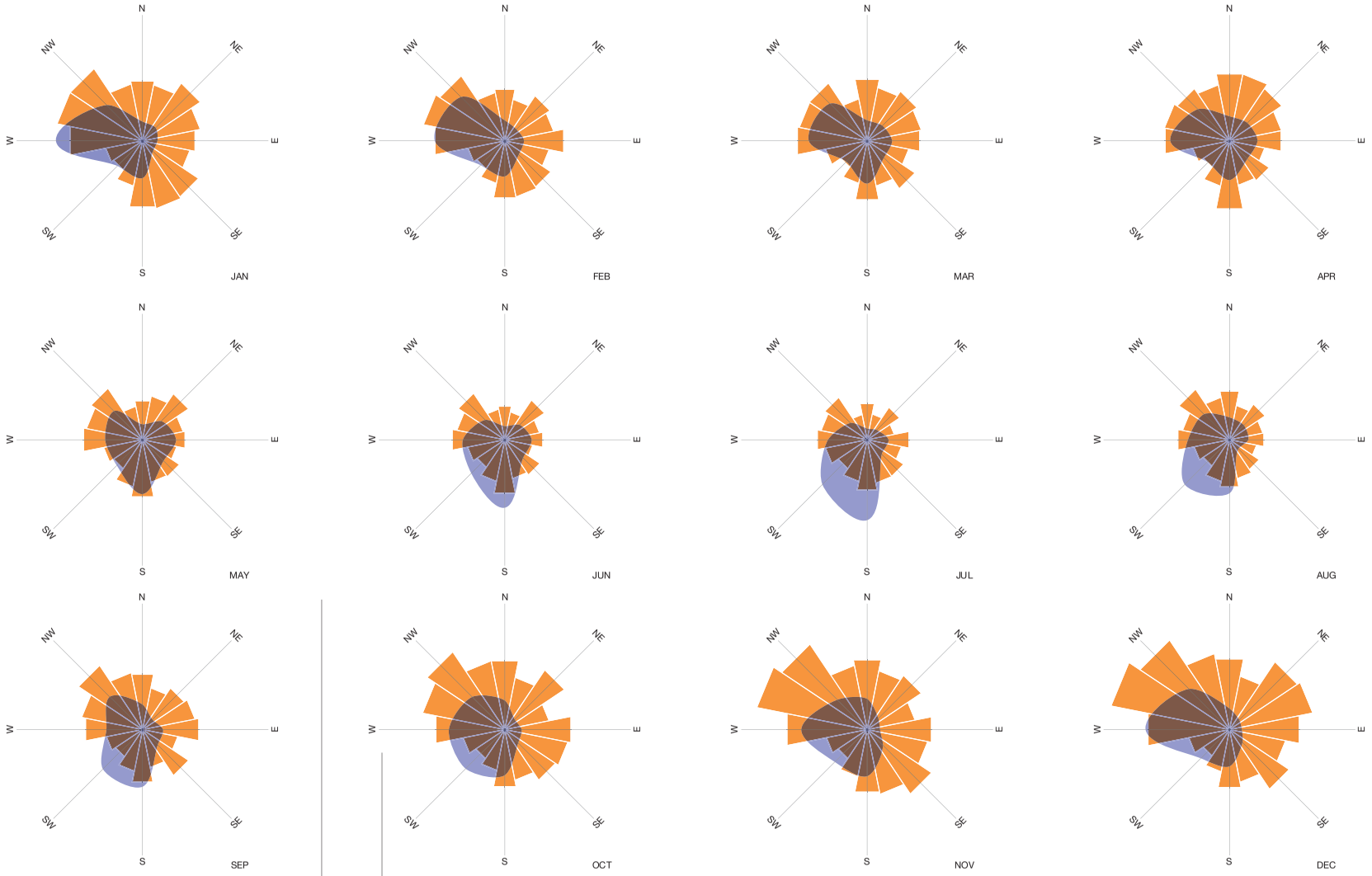
Less than 1km
1km - 9km
More than 9km

Visibility and Cloud Cover

Both Visibility and Cloud cover play a key roll in the interior qualities of a space but also in the view and experience of the exterior condition around. As the data shows, there is between 73-89% visibility of over 9km. This means that the view out of the architecture is key and will not generally be obstructed. Secondly the cloud cover amounts. Although the region may experience

Wind

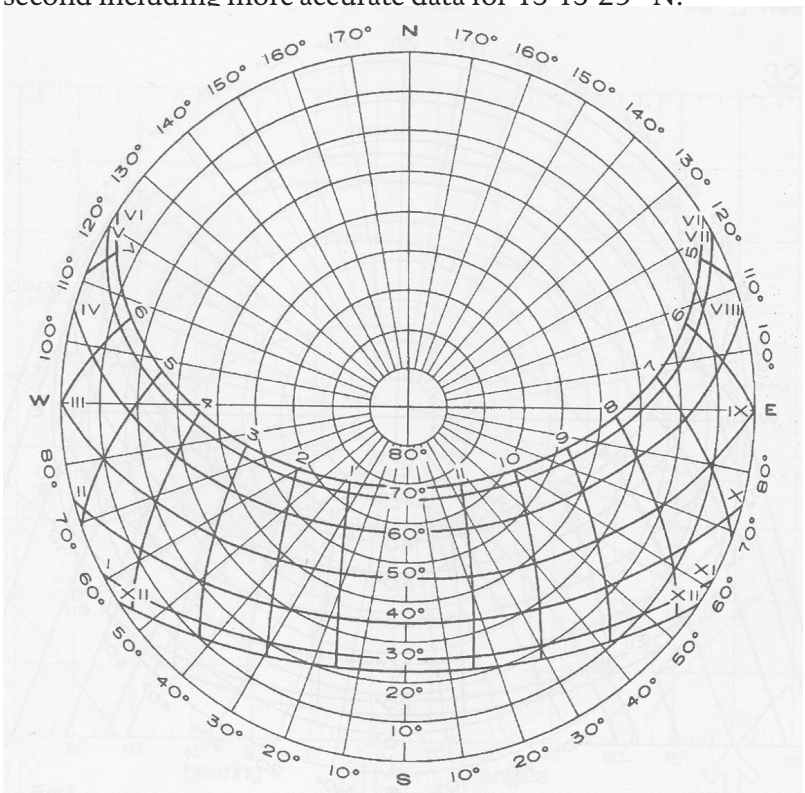
When looking at this series of data, it can be read as follows. The orange cone represents the average intensity of wind from its corresponding direction throughout any given month. The blue curvilinear swatch displays in percentage the frequency of wind from each direction over that same month. There are several way in which this data may be read but there are two which are much faster and more comprehensive. The first is through comparison of orange cones from month to month,. For example it is clear that June - August have far less intense winds than that of November and December. Second takes into account the frequency, for example April and May have fairly light and even winds, whereas December and January have very frequent winds from the West North West, which also happen to be quite strong. This series of wind data although comprehensive and quite telling may be summed up into two key points which says that cold winter winds from the West North West need to be protected from and during the summer months the air is calm and buildings may open up.



Wind Frequency
Wind Strength

Appendix C: Solar Data

This is a recording of relevant solar data for the 44th parallel in the Northern hemisphere(for the southern hemisphere substitute the North and South orientation). This is a graphical representation of the data, a more accurate table can be found second including more accurate data for 45 43’29” N.



(f) 44° N LATITUDE